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USE OF SCIENTIFIC AND TECHNICAL DEVELOPMENT BY INDUSTRY

LIKE its immediate predecessor, which was concerned with scientific man-power, the sixth annual report of the Advisory Council on Scientific Policy, which covers the period April 1952–March 1953*, inclusive, is again concerned with a single topic. The central question engaging the attention of the Council during the past year was the review of the effectiveness of current arrangements for ensuring that the results of research make their contribution to the development of the British economy at the present time—a problem the Council was asked to undertake last summer by the Lord President of the Council, then Lord Woolton. A report on the exploitation of science by industry was submitted to Lord Woolton's successor, the Marquess of Salisbury, on March 27, 1953, and this report is reproduced in full, without further comment, as the Advisory Council's annual report for the year.

Attempting to analyse the reasons for the comparative failure of British industry as a whole to exploit to the full the results of scientific research, the Advisory Council notes that industry is hampered by shortage of scientists and technologists and by the present low level of investment, and recognizes that neither factor can properly be considered in isolation. Many large firms in Great Britain appear to carry on with the minimum of technical change, and backwardness in this respect is, in general, more widespread in the medium-sized and smaller firms. Of the 140,000 manufacturing establishments in Britain, 82,000 employ not more than ten men, few of whom have had the training which is necessary to take full advantage of scientific and technical progress.

The view is accepted that the number of scientists and engineers employed in British industry must be greatly increased and their average quality improved, as well as their distribution within industry; but it is not suggested that an increased supply of scientists and engineers will by itself solve the problem. Their importance must be increasingly recognized by industry: the primary reason why industry as a whole does not make more use of scientists is because large sections of industry, being conservative and complacent, have neither missed them nor asked for them; and in this connexion the Advisory Council refers to the way in which recent scientific and technical developments, by revolutionizing the relations of different industries to each other, have necessitated a new awareness of science among those who direct industry. "It cannot be too strongly emphasized," it is stated, "that unbalanced boards of management, on which technical representation is small or non-existent, are unlikely to be able—even if they were not limited in other ways—to take full advantage of the results of scientific research with the speed and enterprise which are required under modern conditions."

* Advisory Council on Scientific Policy. Pp. iv+11. (London: H.M.S.O., 1953.) 6*d*. net.

Technical backwardness in industry, the Council continues, already apparent before the Second World War, may have been largely due to lack of technical awareness and enterprise; but it has been aggravated by such factors as the domination of the national economy since the War by shortages of steel and power, the urgent need for redressing an adverse trade balance and the demands of rearmament. Such factors have encouraged the development of established industries and also fostered the dangerous belief in some sections of industry that they could afford to ignore the latest developments in science and technology. The view that to-day in Britain we can scarcely expect to live by our industry unless we change the pattern of our production and seek to develop new products and processes, which, by depending on the application of our scientific and engineering skills, will keep us in the forefront, is supported by the export figures which are cited. Last year only £34 million out of £2,500 million of overseas exports represented goods (for example, nylon, penicillin, radar equipment) which were unknown before the War. Even with the inclusion of such things as newer types of aircraft, the figure is still less than ten per cent of the total of United Kingdom exports.

Here, while the report is kinder to British industry than was Sir Henry Tizard in his Messel Memorial Lecture last year, the trend of the argument is the same; but when the Advisory Council comes to discuss the level of investment, it seems to falter where Sir Henry was firm. As elsewhere in the report, admirable restraint is used, and the view that the volume of investment in manufacturing industry is too low, particularly in the development of new products and processes, is reasonably and lucidly argued. Without over-stressing the validity of comparisons with the United States, the Advisory Council believes that the investment figures given in the report suggest that our competitive position is worsening rather than improving, and that investment in manufacturing industry in Great Britain also compares unfavourably with some European countries.

Nevertheless, while the Advisory Council believes that an increase in the volume of investment in manufacturing industry would do more than any other single measure to assist the better exploitation of science by industry, it hesitates to express views on investment policy. It recognizes, indeed, that the subject cannot be ignored, and refers to the possibility that new investment may be deterred alike by the present policy of dearer money and by the prevailing high rates of taxation. It is noted also that the shortage of risk capital is seriously affecting the quality of investment, so that too high a proportion goes into relatively safe forms, and the Council accepts the view that control by licensing of industrial building now has a negligible effect and that the inducements to research and development already provided under our taxation system leave little scope for further relief.

Holding the view, however, that the most effective single measure which would conduce to a far greater exploitation of science by industry would be a significant increase in the volume of investment, the Advisory Council on Scientific Policy seems to assume that no major change in the existing level of investment is to be expected. No one would expect of the Council a detailed examination of financial and economic proposals or policy, but something might at least have been said of the way in which taxation policy, for example, can affect development and encourage or discourage the adventurousness on the part of British industry for which Sir Henry Tizard called so strongly. Representations, presented with the moderation and lucidity which characterize the report in general, would have been the more welcome from so impartial a body as the Advisory Council in a matter which is all too easily bedevilled by party politics.

Apart from its caution here, which would seem to be due to over-anxiety not to offend departmental or party prejudices, the Advisory Council's report is thoroughly realistic. It is pointed out that the volume of research and development carried out by industry would probably increase if the writing-off of capital facilities, or of special facilities needed to ensure organized scientific development, could be expedited. The contribution of the research associations to productivity and in the fostering of development projects is regarded very favourably, though there will certainly be some dissent from the view that large and medium-sized firms rather than small firms benefit most from the work of the associations. The Advisory Council considers that the policy of the Department of Scientific and Industrial Research of developing the work of the associations in the productivity field is likely to increase most economically the output of medium-sized and small firms, though here again it admits that more investment capital would be required. As regards development, it is suggested that some of the research associations are mature enough to identify requirements, for example, for new types of machinery, in the further development of which the National Research Development Corporation might help.

There are few factors responsible for the failure of British industry to exploit science sufficiently which are not touched upon in this report, though it does not enter on discussion of such matters as the influence of restrictive practices by both management and labour, nor of the effect of Government control on initiative and adventurousness. In a reference to Government Departments and development, the Advisory Council shows itself thoroughly aware of the danger of looking to the State rather than to industry and the individual for initiative and adventurousness; and there is no suggestion here that there is a lack of either the skill or the physical resources to enable British industry to enjoy a full share of the benefits to be reaped from recent scientific and technological advances. There is no reason for us to be apprehensive, either, in regard to technique. While there is undoubtedly room for the wider extension in British industry of the most advanced practice, there is every reason, too, for confidence in its ability to apply the results of scientific advance, given the

conditions which the Advisory Council stresses—a greatly increased number of scientists and engineers and a large flow of capital willing to seek investment in productive industry.

Confidence in the industrial future of Britain is derived from the fact that at least some British firms are as scientifically minded and as progressive as their counterparts in other countries. There is no fundamental technical reason why more should not emulate their example; and the Advisory Council has indicated, albeit somewhat tentatively, ways in which Government action could encourage this. It may well be necessary for others to repeat in more forthright terms what the Advisory Council has put so leniently; but the report also illustrates the need for the continuing survey and representations of the Advisory Council on Scientific Policy over its whole field, if the objectives in even one aspect such as that covered by the present report are to be achieved.

There are undoubtedly real advantages in the Advisory Council presenting its considered views on particular topics in such special reports; but it is perhaps unfortunate, particularly at the present time, that the annual report should be used as the medium of publication to the exclusion of discussion of all other topics. No reason is apparent from either the present, or last year's, report why reports on scientific man-power and on the exploitation of science by industry should not have been issued independently by the Council, and its annual report left free for the discussion of general aspects of scientific policy as appropriate. There are various topics of wide importance at the present time and on which scientists would be glad to know what advice the Advisory Council has given the Government. Has the Advisory Council, for example, accepted without protest the Government's procrastination over the proposed Science Centre, or has it pointed out the detrimental effect that such postponement is likely to have on the dissemination of scientific information and thus on the utilization of science by industry? What action has the Advisory Council taken to expedite Government action in the upgrading of selected technical colleges for higher technological education, or to secure the effective co-ordination of higher technological education under the University Grants Committee, as was indicated in an earlier report of the Advisory Council? The failure of the Minister of Education to formulate a policy does not warrant the Advisory Council in leaving this matter with the hope that the Government's announcement regarding the Imperial College of Science and Technology "will soon be followed by effective action". And is there nothing further to report on the supply of science teachers, which so disturbed the Advisory Council a year ago? Earlier reports have referred also to the utilization of the services of scientists and technologists in the Colonial territories and in the nationalized industries. Has the Advisory Council on Scientific Policy nothing further to say on these subjects? Is it satisfied that full use is being made of the services of scientists and technologists in these fields and that their advice is heeded?

There are, in fact, misgivings among scientists as to the use made of scientific advisers in the Colonial Service. The Secretary of State for the Colonies has so far done nothing to prevent the development of an atmosphere in which responsible men of science are unlikely to accept appointments and from which the Commonwealth will quickly suffer. So, too, on the nationalized industries, so responsible a periodical as *The Engineer*, in commenting recently on the annual report of the British Transport Commission, expressed fears that the changes initiated by the Government might seriously endanger technical efficiency, and expressed regret that political considerations had been allowed to introduce changes in organization of doubtful value which were bound to disturb profoundly the work of the Commission and its executives.

There is, in fact, an accumulation of evidence which suggests that little more than lip service is being paid by the Government to the claims of science to be heard in the counsels of the State and that objective advice is being disregarded. At such a juncture the silence of the Advisory Council on these matters is the more disquieting. It should be a prime function of the Council not merely to present advice to the Government, but also to satisfy the world of science that such advice is presented objectively and effectively, and that it receives due and reasonable consideration. It is to be hoped that means will be found whereby the Advisory Council on Scientific Policy will be able, not only to issue reports from time to time on matters of major topical importance, but also to provide the scientific world with an annual account of its activities in the many lesser fields in which scientific progress impinges on everyday affairs.

THE AGRICULTURAL RESEARCH SERVICE

THE Agricultural Research Council, which is appointed by the Committee of the Privy Council for Agricultural Research and Nature Conservancy, is responsible for the general supervision of State-financed agricultural research in Great Britain. Established in 1931, it has marked its coming of age by issuing a 54-page booklet, which is both a directory to the Service and an account of the functions of the Council*.

The recent growth of State expenditure in Britain on agricultural research is remarkable, and reflects the growing recognition of the vital importance of agriculture in the national economy. In 1930 State expenditure on research was about £250,000, in 1940 it was £800,000, in 1950 £2,600,000, and in 1952 £3,200,000. The first figure represents about 0·1 per cent, and the last figure about 0·3 per cent of the gross value of agricultural output in the corresponding year. The figure 0·3 per cent may be considered too low for such an essential industry as agriculture to spend on scientific research; but it should be remem-

* The Agricultural Research Service. Pp. 54. (London: H.M.S.O. 1953.) 2*s.* 6*d.* net.

bered that it is not the industry but the taxpayer that provides the money, and that until the War the taxpayer had no reason to regard increased agricultural production at home as a matter of urgency. The agricultural research service should be satisfied that a four-fold increase in its cost since 1940 indicates that the public now recognizes its importance.

The agricultural research service has no formal constitution, and the term is used to comprise the activities of the agricultural research institutes and units, numbering between thirty and forty, which are financed by the State and supervised by the Agricultural Research Council. The service grew haphazardly. It may be said to have started in 1843 with the foundation of the Rothamsted Experimental Station—the oldest agricultural research institute in the world—by Sir John Lawes as a private venture. Other research institutes, dealing especially with various branches of horticulture, were afterwards founded by private benefactions or by funds provided by growers' associations. University departments also began research in different branches of plant and animal production. One significant result of this haphazard growth has been that there is no *agricultural* research station in Great Britain; but a number of independent institutes each concerned with some specialized branch of agriculture such as dairying, grassland, animal or plant breeding, etc.

Public money was not provided for agricultural research until 1910, and was at first administered by the Development Commission, which was responsible for allocating the money to the various institutes and university departments and thus exercised some co-ordination over the development of agricultural research as a whole. It proposed the setting-up of several new institutes some of which came into being after the First World War, which had at least established the right of British agriculture to survive. The Government's proportion of the cost of research increased rapidly, and as the need for closer co-ordination in the administration of the public funds grew the Agricultural Research Council was set up, first, to act as scientific advisers to the Development Commission, and afterwards to take over the responsibilities for agricultural research formerly discharged by the Commission. Agricultural research, like medical research and industrial research before it, was thus formally recognized as a government responsibility.

One of the first acts of the Agricultural Research Council was to survey the work of the research institutes with reference to current national needs, and it was decided that research on animal diseases should be expanded. The Council therefore set up the first of its own research stations at Compton, Berks, to study contagious abortion and other diseases of livestock, and afterwards three other stations. Ten smaller research 'units', concerned with special aspects of agricultural science, are also directly administered by the Council and operate in university departments where their work can be most effectively carried out. Through these units the Council can support fundamental research for which the environment and facilities of a university are often more suitable than those of a State-supported research station. In all, the Council has a staff of nearly a hundred qualified scientific workers in its stations and units.

The Council's aim is "to review, co-ordinate and facilitate all agricultural research in progress, to promote new research where necessary, and to ensure so far as possible that the scientific man-power and other resources available are used to the best purpose". Its prime duty is thus co-ordination, the necessity of which is obvious when the wide field of agricultural research, embracing almost every branch of natural science, and the independent status of most of the research institutes are borne in mind. Besides operating the fourteen stations and units directly under its control, the Council gives advice (which, since the Council holds the purse strings, may occasionally amount almost to commands) on research programmes, staff and budgets to twenty-one institutes in Great Britain that derive most of their funds from the Ministry of Agriculture or the Department of Agriculture for Scotland. No central direction of research, however, is attempted, it being a cardinal principle of the Council that research workers should be free to develop their individual interests within the general requirements of the service. Members of the Council are selected mainly on account of their eminence in science and their ability to appreciate the conditions in which scientific research can best be carried out. There appears to be adequate appreciation of the necessity to promote fundamental research, of which a certain amount is done with public money at research institutes; but in general the Council considers that fundamental research is the province of the university departments over which the Council has no control, although it maintains close contact with them and, indeed, makes numerous grants to them to assist lines of research which may assist the solution of some agricultural problem.

Three standing committees—dealing with animal research, plant and soil research, and agricultural engineering—together with the Soil Survey Research Board assist the Council in formulating a research policy, and these in turn can call upon the advice of twenty-five technical committees or conferences the purpose of which is to keep in touch with problems and progress in specific subjects such as animal climatology, foot-and-mouth disease, dairy machinery, bracken control, drainage, red-spider mite and strawberry diseases. In this way a general policy can be drawn up without losing touch with the requirements of the individual research workers on whose ability and skill the Council recognizes the success of the research service must ultimately depend.

Research policy, particularly in agriculture where results appear slowly, must be long-term; nevertheless it has to be related to the shorter-term agricultural policy of the Government. When the Agricultural Research Council was established in 1931 the trend in government policy was towards the encouragement of livestock farming, and, as already stated, the Council paid special attention to research into animal diseases. Its aim is still to keep in step with post-war

agricultural policy with its emphasis on an all-round increase in agricultural production. The Council maintains effective liaison with the Ministry of Agriculture and the Department of Agriculture for Scotland through the two Agricultural Improvement Councils that were set up during the War for that purpose and to advise the government departments on the best means of incorporating research results into practice, and the Agricultural Research Council on the problems requiring investigation. The Agricultural Improvement Councils are closely linked with the advisory services which, in their turn, are in direct contact with the farming community. Thus effective channels exist whereby not only can prompt application of the results of research to farming practice be achieved, but equally the demands of the agricultural industry can be brought to the notice of scientists at the highest level. The administration of such a complex service, from the many first-rate scientific intellects now working for agriculture to the vast multitude of farmers who may make use of the sifted and intermingled results of specialized research, is necessarily complex, but it works remarkably well. Much of the credit for that is due to the spirit of partnership with which the Agricultural Research Council has imbued the whole of the research service.

AUTOMATIC CONTROL OF MECHANISMS AND INDUSTRIAL PROCESSES

Servomechanisms and Regulating System Design

By Harold Chestnut and Robert W. Mayer. (General Electric Series.) Vol. 1. Pp. xiii+505. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1951.) 62*s*. net.

Fundamentals of Automatic Control

By G. H. Farrington. Pp. xii+285. (London: Chapman and Hall, Ltd., 1951.) 30*s*. net.

An Introduction to the Theory of Control in Mechanical Engineering

By R. H. Macmillan. Pp. xiv+195. (Cambridge: At the University Press, 1951.) 30*s*. net.

ONE of the most interesting features of the development, during the past decade, of scientific thought in the field of applied science has been the building up of a philosophy of 'systems having a closed sequence of dependence'. Such systems, in the engineering field, may range in type and application from an automatic pilot for the navigation of an aircraft to the control of a complete chemical manufacturing process. Some of the theoretical concepts which have evolved from the coalescence of several independently developed branches of theory concerning control and communication have proved to be of a very general significance, not only in relation to engineering but even in such apparently unrelated fields as economics and biology.

The three books under review, although directly concerned with the engineering applications of control theory, serve to illustrate both the wide scope of the subject and the variety of ways in which it may be approached. All three start from simple fundamental considerations. H. Chestnut and R. W. Mayer, in their book on "Servomechanisms and Regulating System Design", after developing in a straightforward fashion the basic differential equations of electrical and mechanical systems, deal in considerable detail with the method of solution based on the Laplace transform and apply the method to very simple control problems. The central problem of control system behaviour, that of stability, is given very thorough consideration; in particular, steady-state analysis in terms of the Nyquist criterion. This is followed by a fairly detailed review of control system elements, mechanical, hydraulic and electrical, and their transfer functions, and of types of feedback control systems. Then the application of the complex plane plot in system analysis and in system design is treated.

Following this, attention is directed to the advantages for purposes of synthesis, rather than analysis, offered by design methods based on the work of H. W. Bode on the relationship between attenuation and phase in electrical networks, and the 'attenuation and phase diagram' method is developed and employed on representative problems including multiple-loop and multiple-input systems. The book concludes with a chapter describing the use of charts relating the steady state and transient response to the open-loop attenuation characteristics necessary to obtain the response.

This book constitutes an introduction to a practical method of control system design, and the development of the subject is clear and well suited to its direct purpose. It must, however, be recognized that there is a gap between the development from fundamental principles and the design method based on Bode's theorems which is bridged in only a rather slender fashion. There is an excellent bibliography, and a series of examples for solution is given at the end of the book.

"Fundamentals of Automatic Control", by G. H. Farrington, is essentially a presentation of the principles of automatic control applied to industrial processes. Although the principles underlying the automatic control of a process or of a complete plant may be basically the same as those governing, say, the control of position of the output member of some form of electromechanical system, it is immediately evident, on comparing two text-books dealing with these separate branches, that the approach and much of the nomenclature differ widely. This book formulates in a very satisfactory way the mathematical equations representing typical generalized control systems, and develops performance criteria. The theory is built up on considerations relating to the control of such quantities as temperature, pressure, fluid flow or humidity. Of particular interest is the utilization in the solution of process control problems of electrical analogues for the actual physical phenomena involved and the establishment of the equivalent electrical networks. The electrical analogue is also turned to good account in a chapter dealing with systems having distributed constants, the formulæ of the electrical transmission line being used as a basis for the analysis. There are chapters dealing with the principles of plant analysis and with the analysis of controlling units of pneumatic type, and there is a brief final section on control selection and adjustment. Taken as a whole, the treatment is rather condensed, and there are a good many instances of topics being introduced but developed in

too sketchy a fashion to be really useful. Process control concepts and nomenclature are in general less obvious and less readily grasped than those of position control, and the introductory sections of the book create the impression that more effort could usefully have been devoted to elucidation and clear statement. The book does, however, give a comprehensive presentation of the process control problem.

The third book, entitled "An Introduction to the Theory of Control in Mechanical Engineering", does, in fact, draw most of its illustrations from mechanical engineering practice; but the treatment is quite general, and electrical elements and concepts are introduced wherever they are useful or appropriate. A particularly valuable feature of this book is the co-ordination of the analysis of systems in terms of transient response with that in terms of harmonic response. Both analyses are developed in a clear and straightforward fashion, and simple statements of their fundamental mathematical bases are given in two appendixes. The treatment proceeds from a study of typical simple systems to the consideration of general transfer functions and control sequences, and finally to graphical methods for the determination of stability and overall response. The book gives an exceptionally well-balanced introduction to the theory of servo systems, and in scope and presentation it is well adapted to the use of undergraduate students.

The other two text-books, although both starting from elementary considerations, have more specialized aims, and they are better suited to the reader whose branch of specialization is already determined.

J. Greig

COMPARATIVE PHYSIOLOGY OF LOWER ANIMALS

A Physiological Approach to the Lower Animals By J. A. Ramsay. Pp. ix+148. (Cambridge: At the University Press, 1952.) 15*s*. net.

In this interesting and stimulating book Dr. J. A. Ramsay discusses a number of the more important aspects of comparative physiology which one would expect to find expounded in a text-book; but, by confining himself to a limited number of well-investigated and well-chosen examples, he avoids cluttering up his discussion with that bulk of information by which a text-book often conceals general principles from the beginner. Dr. Ramsay's book is about the physiological processes of living animals, and these are dealt with comparatively, topic by topic, starting with nutrition and ending with behaviour. It is not a text-book, and some important topics are deliberately excluded as unsuitable to the author's purpose. General principles about the working of whole animals are most effectively presented; the physiology of constituent cells is avoided as far as possible. Among many topics discussed in a most lively way may be mentioned the following: the difficulties of digesting plant material in which the protoplasm is enclosed by cellulose walls, methods of trituration, and the breakdown of cellulose by bacteria in the gut; the hydraulic aspects of circulation in the invertebrates, and the functions of the auricles and pericardium; the interplay of musculature and skeleton, including the 'hydrostatic skeleton' of many lower invertebrates as well as the hard skeleton of arthropods and vertebrates. In the final chapter the behaviour of animals is discussed in a manner likely to arouse the spirit of inquiry in not a few of Dr. Ramsay's readers.

The emphasis of the book is on general principles, and therefore on the results of physiological investigation rather than on the means. This may prove a disadvantage to those who have no experience of physiological methods but who understand and accept results more readily when they know how these results have been obtained. There is, for example, a considerable discussion on nervous co-ordination, including the grading of sensation and of motor response. It is theoretically sufficient for this discussion to state that stimulation of a nerve leads to the passage of small potential charges of short duration which travel very quickly. In spite of the diversion which would be created, it might be easier for a student to understand the mechanisms of nervous co-ordination if he was in possession of an elementary picture of the characteristics of the action potential. The presentation of general principles also inevitably leads to some over-simplification: for example, temperature control is stated to be confined to birds and mammals, although it is practised communally by the domestic bee.

These, however, are minor criticisms and will have no validity if the book is used, as it should be, during the first year of a university degree course in zoology. It will, in fact, make excellent reading for a university student's first long-vacation. It should not be used except with a reasonable knowledge of the general zoology and anatomy of many of the types discussed, and will form an excellent companion to these studies; it is therefore only suitable for the most advanced pupils at school. It will prove stimulating and enlivening to all keen teachers of zoology in schools, and not least to those who were trained in less physiological times. There is one obvious mistake in the legend of Fig. 18; apart from this, the book is excellently produced and the text is illustrated with a number of simple and clear diagrams.

J. A. Kitching

BIRDS OF EAST AFRICA

Birds of Eastern and North Eastern Africa By C. W. Mackworth-Praed and Capt. C. H. B. Grant. (African Handbook of Birds, Series 1, Vol. 1.) Pp. xxv+836+59 plates. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1952.) 45*s*. net.

This is the first of two volumes—the second is already in the printers' hands—of a work which will be eagerly welcomed by the many people in the eastern parts of Africa who are interested in the rich and varied bird-life of that continent. It has been written by two authorities of high repute in the subject, and they have surely succeeded in their aim "to give others the book they themselves wanted when they first visited and lived in Africa". The area covered is eastern and north-eastern Africa from (and including) the Sudan to the Zambesi.

The authors have been compiling the information for eighteen years. During that time they have published a stream of papers and notes in the ornithological journals, giving facts that were new or clearing up points of difficulty. This has enabled them to issue their summary in handbook form, avoiding discussion and omitting references. For the field worker this has obvious advantages; and for

the specialist the details of evidence and argument are available, in addition, on the library shelves.

For each species and recognized geographical race found or occurring in the area, the essential facts are given under the heads of distinguishing characters, general distribution, range in eastern Africa, habits, nest and eggs, food, call and (where applicable) distribution of other races of the species; the particulars relating to reproduction are omitted where the species or race is not known to breed in the area. English and scientific names, with full references for the latter, are of course also given; and the species are consecutively numbered. In addition, there is a brief general note on each family and a key for the identification of the included species.

There are little marginal maps showing the distribution of each species or race. This is an attractive feature, which one hopes to see followed in other works: another book which is in course of preparation has indeed independently adopted the plan. The illustrations of birds include marginal drawings in black-and-white and numerous figures in coloured plates: although the colour reproduction does not seem to be of the highest standard, both are well suited to their purpose. There are also some plates of photographs from life.

The book is very well printed by lithography, and attractively produced. In every way it should be a pleasure to use, and its availability should be a great stimulus as well as help to the further study for which abundant scope remains. An index of English names is lacking, but it may be intended to provide this for the work as a whole at the end of the second volume.

This first volume deals with the non-passerine birds, from ostriches to pittas. The groups that bulk most largely are the herons and storks, ducks and geese, birds of prey (no less than eighty-three species), game-birds, plovers and their allies, pigeons and barbets. Of the last, there are thirty-three species in eastern Africa, including "the Tinker Birds, Brain-fever Birds and others whose monotonous notes have been commented on with varying virulence". The richness of the avifauna reflects not only the extent of the area but also the variety of its country, from desert to primeval forests, from coast to great lakes, and from swamps to highlands, the last culminating in places with the zone of giant heather and lobelias, leading up to snow-clad peaks.

LANDSBOROUGH THOMSON

CHEMICAL CALCULATIONS

Problems in Physical Chemistry

By Prof. Lars Gunnar Sillén, Paul W. Lange and Carl O. Gabrielson. (Prentice-Hall Chemistry Series.) Pp. xiii+370. (New York: Prentice-Hall, Inc., 1952.) 6.65 dollars.

Chemical Calculations

An Introduction to the Use of Mathematics in Chemistry. By Prof. Sidney W. Benson. Pp. xi+217. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.) 24*s*. net.

A TRAINING in calculations is an essential part of the education of a chemist. The student (or the teacher) cannot really understand a quantitative physical law until he has applied it in numerical problems. Books of more-or-less elementary chemical calculations are fairly plentiful; but—apart from Wolfenden's "Numerical Problems in Advanced Physical Chemistry" (1938)—none had been published during the past quarter of a century that was reasonably modern in outlook and sufficiently advanced for an honours class in physical chemistry. This need is now met by the first of the two books under review.

"Problems in Physical Chemistry", by L. G. Sillén, P. W. Lange and C. O. Gabrielson, is an American version, prepared by the original authors from the second Swedish edition, of a book which appears to have been very successful in Scandinavia. It comprises eleven chapters with the following titles: first law of thermodynamics; second and third laws of thermodynamics; partial quantities, activities; law of mass action, gas equilibria; solution equilibria; chemical electromotive forces; solubility, complex and redox equilibria; acid-base equilibria; transport of electricity by electrolytes; rate of reaction; phase boundaries, atoms and molecules. (The ground covered is therefore correctly described in the title as physical chemistry rather than chemical physics.) Appendixes deal with methods of numerical calculation, and give lists of symbols used and of journals quoted and the answers to the problems. There are adequate author and subject indexes.

Each chapter begins with a section (10–20 pp.) summarizing the principles to be used and illustrating them by worked examples, and then sets out a large number of problems for solution. Altogether there are about 750 of these, nearly all of them taken from original papers to which references are given. They are thus real-life problems rather than arbitrary academic exercises, and anyone (graduate or undergraduate) who works through a selection of them will acquire a good knowledge of physical chemistry and its literature. Though the authors explicitly disclaim them as substitutes for a text-book, the introductory sections are excellent; they contain a large amount of useful information in a very concise form and are up to date. Wise guidance is given as to the accuracy of experimental data and to the various levels of approximation needed in calculations based on them. Occasionally the authors comment on the original work used in the problems, and their comments are always most illuminating.

This is certainly one of the best books of advanced chemical calculations at present available. It would be a pity were the rather high price to restrict its general adoption as a standard text for all honours courses.

The other book, "Chemical Calculations", by S. W. Benson, is much more elementary, despite the solemnity of its sub-title. It is intended to coax a first-year (intermediate) student, who has no mathematics, into some understanding of the numerical way of dealing with chemistry. It has seventeen chapters covering the usual range of topics in elementary general and physical chemistry, each chapter ending with a group of ten or twenty simple exercises. The book starts with such matters as converting x grams to pounds or the use of logarithms, and reaches as far as simple ionic and redox equilibria. No calculus is introduced. What it sets out to do, the book does well enough; it is clearly and interestingly written, and—at its level—sound and up to date. (But it surely sets the cart before the horse in calling the van t'Hoff isochore the "Arrhenius equation for equilibrium constants".) To those students who can afford to pay a relatively high price for an elementary book, it may well prove very useful.

J. C. SPEAKMAN

Radio Interference Suppression

As Applied to Radio and Television Reception. By G. L. Stephens. (Published for *Wireless World*.) Second edition. Pp. 132. (London: Iliffe and Sons, Ltd., 1952.) 10*s*. 6*d*.

IN view of the regulations made recently for the suppression of interference in the television frequency band, the publication of this up-to-date guide on suppression methods is opportune. The book is a revised edition of the original publication by G. W. Ingram in 1939. It is intended for all those who have to do with the actual process of suppression, from the designer of electrical equipment to the service engineer who has to cope with specific cases of interference. It is essentially a practical book, and only an elementary knowledge of the theoretical side of the subject has been assumed.

In the first chapter the origin of interference and its modes of propagation are simply explained. After discussing the general principles of suppression, the author shows in a well-illustrated chapter how they may be applied to a wide variety of sources of interference ranging from domestic appliances and motor-car ignition systems to industrial equipment and trolley-buses. A separate chapter has been devoted to marine applications. In discussing the specification requirements of suppressor components, the author rightly emphasizes the need for reliability especially from the safety point of view. Methods of locating interfering sources and of measuring the radiated field strength are briefly described. In the last chapter, on suppression at the receiver, one is rather surprised to find television 'ghosts' and picture flutter included. Also in this chapter occurs an unfortunate disagreement between the text and the caption of Fig. 61: the text correctly gives the stub length as a quarter of a wave-length. To the engineer and research worker who will regard this volume as an introduction to the subject, the bibliography will serve as a useful guide for further study.

B. G. Pressey

Progress in Metal Physics, 3

Editor: Dr. Bruce Chalmers. (Progress Series.) Pp. viii+334. (London: Pergamon Press, Ltd.; New York: Interscience Publishers, Inc., 1952.) 48*s*.

THIS volume, the third of what was originally intended to be an annual series, compares favourably with its predecessors. Three of the articles, namely, those on properties of metals at low temperatures (D. K. C. MacDonald), recent advances in the electron theory of metals (N. F. Mott) and ferromagnetism (U. M. Martius) are good reviews in established branches of pure physics, whereas the other articles deal more directly with subjects of metallurgical significance. First, there is an excellent review on the crystallography of transformations (J. S. Bowles and C. S. Barrett), and an article on twinning (R. Clark and G. B. Craig) which although interesting does not clarify—a circumstance due rather to the state of the subject than to any defection on the part of the authors. G. B. Greenough contributes a very well-informed chapter on quantitative X-ray diffraction observations on strained metal aggregates, while the article on recrystallization and grain growth (J. E. Burke and D. Turnbull) manages to combine a formal approach to recrystallization kinetics with a critical selection from the massive amount of experimental information which has accumulated in this field. Finally, the editor gives a very readable account of the structure of crystal boundaries.

This series is primarily for research workers, both physicists and physical metallurgists, who have much common ground. However, one might have hoped that the valuable contributions to pure physics, on one hand, would have been balanced, on the other, by some articles more closely related to metal technology. Some effort to bridge this gap was made in the first volume, but not in the present one.

R. W. K. Honeycombe

Mathematical Models

By H. Martyn Cundy and A. P. Rollett. Pp. 240. (Oxford: Clarendon Press; London: Oxford University Press, 1952.) 21*s*. net.

AN exhibition of mathematical models staged by the mathematical sixth-form of a school twenty-five years ago was the forerunner of those held to-day by schools, colleges and societies in order to provide that contact with reality so essential in demonstrating ideas and principles in the symbolic world of mathematics. The excellent bibliography shows how scattered is the literature of the subject, and teachers and men of science will be grateful to the two authors for writing a permanent record of these lessons of experience in this fascinating and decorative field.

The carefully written text, with its clear illustrations and photographic plates, gives sufficient detail to enable pupil and teacher to construct many models and diagrams, including dissections, loci and envelopes (by folding, drawing and stitching), tessellations (plane and solid), polyhedra, ruled surfaces, simple machines for solving equations, and linkages. The longest and most attractive section gives nets and constructional hints for the regular, the stellated and the Archimedean polyhedra and their duals, the regular compounds and deltahedra. It certainly is an admirable collection for the classroom.

This delightful book should be in the hands of every mathematics teacher and in every school library.

Personality Development

By J. S. Slotkin. Pp. x+401. (New York: Harper and Bros.; London: Hamish Hamilton, Ltd., 1952.) 36*s*.

THE author, who is a social anthropologist, begins by saying that he has tried to work out a systematic theory of personality development, from the hypotheses and evidence of various relevant sciences. The material is, however, systematic only in so far as it has been distributed under four major headings: inheritance, socialization, culturization and individualization. Within each of these fields the approach is mainly descriptive and anecdotal and is adorned by a wealth of quotations from ancient and modern writers.

It may well be that in the meantime this kind of approach is repaying. Certainly it does not suffre from the aridity of some recent statistical work in the same field. But perhaps we can only be scientific about people if we are content to be dull.

Though no major contribution to the study of personality has here been made, the book is extremely readable and the material is freshly presented. Anyone in search of illustrations for his own lectures or suggestive instances to help forward his own thinking will find that this is an excellent anthology, and perhaps the only one of its kind.

NATIONAL PHYSICAL LABORATORY, TEDDINGTON

OPEN DAY

AN open day was held at the National Physical Laboratory, Teddington, on Friday, May 15. In addition to the Laboratory's General Board, which held its annual meeting in the afternoon, the guests included some twelve hundred representatives from universities, government departments and industry. Of the two hundred exhibits, more than ninety had not been shown previously; the following notes describe briefly some of the items which most interested the visitors.

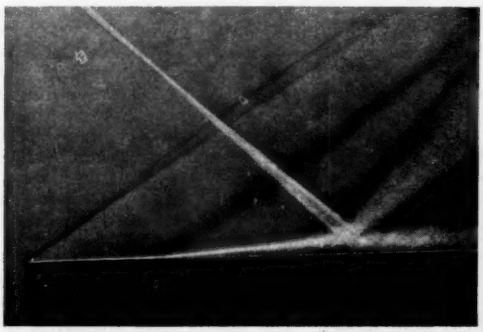
The Collins' helium cryostat, which was demonstrated by the Physics Division, had only recently been installed, but was already producing liquid helium in quantity. This cryostat is manufactured by an American firm and the equipment at Teddington, obtained through the funds of ECA, is the first to be installed in Britain. The great merit of the helium cryostat is that it avoids the use of hydrogen, and the risk of fire and explosion is therefore eliminated. The low-temperature plant at the National Physical Laboratory will be used in the standardization of thermometers and in the study of the crystalline properties of metals such as steel. Work has already been done, using the new apparatus, on the state of internal strain of metal specimens; but the main application, to begin with, will be for the measurement of the entropy of pure chemicals.

The Physics Division also demonstrated methods of measuring radioactive isotopes. Artificial radioactive isotopes are now widely used for medical and industrial purposes, and for certain applications in medical, biological and physical research the highest possible accuracy is desirable. The National Physical Laboratory is collaborating with other laboratories in Britain and with those in the United States and Canada in order to establish national and international standard methods of measurement and standard specimens of radioactive isotopes, particularly for the clinically important isotopes of sodium, phosphorus, cobalt, iodine and gold. As already announced in *Nature*, a service for the supply of standard solutions of radioactive iodine-131 has already been established by the Laboratory, and this service will later be extended to include other important radioactive isotopes. The best accuracy attainable (about ± 2 per cent) in the measurement of the active constituent is less than that traditionally thought of in connexion with other physical measurements; still wider limits are quoted for the more complex isotopes.

Some of the older tunnels in the Aerodynamics Division of the Laboratory have already been closed down and the building in which they were housed has been modified to provide a small lecture hall and to accommodate the Mathematics Division. The up-to-date requirements of aerodynamics research are being met by the provision of new tunnels to augment the existing high- and low-speed tunnels. Two new tunnels, with working sections 36 in. × 14 in. and 25 in. × 20 in. respectively, are nearing completion and will provide the larger-scale facilities required for some of the high-speed work. Both tunnels have a range of Mach number from 0 to 1·8 and are of the induced-flow type. A special strain-gauge balance has been developed for measuring three components of the aerodynamic force (namely, normal force, pitching moment and longitudinal force) acting on a model in a supersonic tunnel. The model is attached to a special form of support, the members of which are stressed by the forces acting on the model, and resistance strain-gauges cemented to the members convert each of the three component forces into electric signals which operate chart recorders. It is possible to alter the incidence of the model to the airstream while the tunnel is running, and the whole equipment can be remotely controlled.

The phenomena which occur when a shock wave interacts with the boundary layer on the surface of a body are of fundamental importance in most problems of high-speed flow. Experimental studies of the interaction have been in progress at the Laboratory for many years and, as a result of recent experimental and theoretical work, the major features of the problem are now understood. Most of the recent experiments, the results of which were on show, have been made in a specially constructed wind tunnel which enables the Mach number (which determines the effects of the compressibility of the air) and the Reynolds number (which determines the effects of the viscosity of the air) to be varied independently over a large range. An interesting film has been prepared demonstrating the interaction between a shock wave and the boundary layer (see photograph).

The increased use of high-speed wind tunnels has stimulated the demand for small metal aerofoils made to precise limits of form and size. There is a particular demand for 'three-dimensional' aerofoils of the delta-wing type, where the section diminishes progressively from root to tip. It is possible to make such models to any degree of accuracy by cutting a large enough number of tangential planes enveloping the form required. The Metrology Division of the Laboratory has evolved a method of manufacture using an accurately set milling cutter to generate the required tangential planes on the blank, which can be precisely rotated and tilted. The models are made in mild steel or brass and a limited number of planes are cut so as to leave 0·000 5 in. excess metal at the intersection of adjacent planes. The excess



Photograph showing the separation of a laminar boundary layer upstream of a shock wave

metal is removed with fine emery, and after final hand-finishing the surface is accurate to within 0·001 in. of the required form. The Metrology Division has also developed a simple microscope method of checking the dimensions of the models and relating measurements made on one side of the model to those made on the other.

The Division has recently acquired a special lathe for producing diffraction gratings by the Merton process. The lathe, which will cut accurately spaced threads ranging in pitch from 100 to 30,000 threads per inch, will be used also to produce the surface of the cylinders on which the master threads are ruled. When scribing 30,000 threads per inch, the tool slide, which carries the diamond and which weighs more than 50 lb., travels quite smoothly at the rate of about 1/16 in. per hr. For every inch of travel of the slide, the diamond cuts a groove more than a mile long.

Apparatus for the measurement of the dielectric constants of pure liquids for use as standards for physico-chemical work was demonstrated by the Electricity Division. Standards are required in the range of dielectric constant from two to approximately thirty, and the Division has so far made determinations for benzene, nitrobenzene, ethylene dichloride and *cyclo*hexane. Benzene from four different sources of supply has been used, and the agreement between the results obtained after two distillations and a drying process is very satisfactory. The value obtained in each case, 2·283 at 20° C., is also in close agreement with the less accurate determinations of the dielectric constant of benzene made at the Laboratory in 1926. Ethylene dichloride, which contains impurities affecting the dielectric constant and making its precise determination extremely difficult, has a value at 20° C. of about 10. Nitrobenzene, which suffers from the same drawback, has a dielectric constant of about 35 at the same temperature. *Cyclo*hexane, unlike benzene, is not hygroscopic, and determinations of its dielectric constant give the same value for the 'as received' condition as is obtained after the double distillation and drying process. Unfortunately, there is no standard grade for *cyclo*hexane of high purity.

The Control Mechanisms Section of the Metrology Division has developed a method of storing and tabulating information, using first a magnetic tape for recording the information at high speed. This information is later tabulated by a slow-speed printing device such as an automatic typewriter. In the system used, digits and signals for typewriter operations are stored on single-channel tape as 20-millisecond pulses of one, two, three or four fixed frequencies. Letters can also be stored if two additional frequencies are used. The recording is decoded using frequency-selective filters setting a relay system corresponding to the typewriter operation to be carried out, for example, typing a digit, spacing or carriage return. The standard electric typewriter used has been fitted with solenoids so that it can be operated automatically. The maximum typing speed is about eight strokes per second.

The Mathematics Division showed a card-operated typewriter which has been adapted for use with the ACE pilot model. The results from the latter are obtained on punched cards, and in order to print them a commercial punched card unit has been modified to operate a commercial electric typewriter at a printing rate of eight characters a second. The ACE pilot model itself, the Laboratory's prototype high-speed electronic digital computer, has been working satisfactorily for about eighteen months and has dealt with problems concerned with mathematical physics, linear algebra, ray tracing, flutter in aircraft, etc.

The crystalline appearance of fracture in mild steel when it breaks in the manner usually referred to as 'brittle fracture' is caused by the fracture occurring across the cleavage plane of the individual crystals. An understanding of the mechanism of this type of failure obviously requires a knowledge of the cleavage strength of iron crystals, and the most straightforward manner of determining this strength is by the use of single crystals, so that no interference from grain boundaries will be experienced if the crystal is broken in tension. At ordinary temperatures, a plain single crystal of iron cannot be broken along the cleavage plane by plain tension, as the crystal yields by slip at a much lower stress than the cleavage strength. At lower temperatures (about − 200° C.), the cleavage strength may be less than the yield stress, and if so the crystal will break with a cleavage fracture without appreciable deformation.

For experiments carried out by the Metallurgy Division, small tensile test pieces consisting of single crystals are made by a strain-and-anneal method, the final dimension over the test length being obtained by electrolytic machining, leaving the surface of the crystal in a highly polished condition. The orientation of each crystal is determined by an X-ray method, and the test-pieces are broken in a micro-testing tensile machine, the test-pieces being cooled to a low temperature in specially designed Dewar flasks. Results obtained so far indicate that over a wide range of orientation single crystals of iron are still completely ductile at − 196° C., but a change to completely brittle behaviour may occur if the orientation is such that a 100 cleavage plane is inclined to the stress axis at angles not less than about 80°.

The highly reactive nature of titanium makes the determination of its melting point extremely difficult. The Metallurgy Division has, however, devised a technique which reduces to a minimum the possibility of contamination while the melting point is determined under black-body conditions. The specimen, a small cylinder about $\frac{3}{4}$ in. long and $\frac{1}{4}$ in. diameter, rests in a zirconia crucible provided with a lid with a sighting hole. A recess in the base of the specimen ensures that only a small area of metal is in contact with the crucible. During an observation, the filament of an optical pyrometer is focused on the base of a small axial hole drilled in the specimen. The specimen is slowly heated in a furnace consisting essentially of a tungsten spiral surrounded by radiation shields made of tantalum and molybdenum foil. The spiral, shields and electrodes are enclosed in a water-cooled evacuated cylinder. When melting begins, molten metal fills up the hole in the specimen and disturbs the black-body conditions. The furnace is then shut down before the specimen collapses and reacts with the crucible.

The melting points of nickel and iron as determined in this apparatus are within 3° C., and that of platinum within 10° C., of the accepted melting points of these metals. The melting point observations obtained for titanium are reproducible to within

3° C., and a mean value 1,660° C. is considered to be accurate within ± 10° C., which is the estimated accuracy of the pyrometer.

To commemorate the centenary of the date when Kew Observatory first undertook the accurate calibration of barometers, the Laboratory had arranged a small exhibition of historical records and apparatus in the hall of Bushy House. The exhibits included two standard barometers of 1854 and 1858; when it was formed in 1900, the Laboratory took over with the Kew Observatory much of the work on the standardization of instruments which until then had been the responsibility of the Observatory.

NEW MAGNETIC MATERIALS OF HIGH COERCIVITY

By Prof. L. F. BATES, F.R.S.

DURING the past five to ten years, considerable strides have been made in our understanding of the theory underlying the production of materials of high coercivity. According to the domain concept of ferromagnetism[1], we picture a ferromagnetic metal as made up of a very large number of small regions or domains. Each of these is magnetized, more or less to the complete degree of saturation appropriate to the temperature of the material, with the direction of magnetization parallel to one of the directions of easy magnetization, these being the edges of the crystal cube in the case of iron. We think that the initial permeability of a material is determined by the ease with which boundary movements between adjacent domains can take place, so that any domain in which the direction of magnetization is more nearly aligned with respect to an applied magnetic field may grow in volume, at the expense of neighbours the magnetizations of which are less well aligned, simply by boundary displacement.

But let us suppose we are dealing with particles which are so small that they are, in effect, single domain particles with no domain boundaries inside them. It then follows that it may be difficult to change the direction of magnetization of such a particle, particularly if it possesses marked magnetic anisotropy, that is, if a crystal of the substance is much more easily magnetized along certain directions than along others—or if the particle is of a special shape, so that large demagnetization fields may arise if it is magnetized along certain axes of shape. Consequently, it should be possible to prepare permanent magnets from materials which formerly were regarded as quite unsuitable for such purposes, such as pure iron. At the Physical Society Exhibition this year, the Salford Electrical Co., Ltd., exhibited 'Gecalloy Micropowder Magnets' made from finely powdered iron. The powder is given an insulating coating and mixed in a conventional dough mixer with heat supplied from below. It is then prepared in a variety of shapes by the use of special press tools and powder presses. The new products are important because of their lightness—since they are about half as dense as ordinary permanent magnets—and because of their insulating properties. Incidentally, soft iron pole pieces are sintered as an integral unit with sintered alcomax alloys ('Sincomax') by Messrs. Murex, Ltd., who thus make many sintered permanent magnets of intricate shape.

The behaviour of permanent magnets made of 'Alnico' has been explained by Stoner and Wohlfarth[2] on the assumption that the material consists of finely divided particles, shaped as prolate spheroids, embedded in a weakly magnetic matrix. Now, we know that such iron – nickel – cobalt – aluminium – copper alloys are given exceptionally valuable properties by exposing them to a magnetic field while they are being cooled from a high temperature. The permanent magnetization parallel to the direction of the applied field is, of course, obtained at the expense of the permanent magnetization perpendicular thereto. We also know that if we take a single hexagonal crystal of cobalt it is comparatively easy to magnetize the crystal parallel to its axis, while it is much more difficult to magnetize it in the basal plane. Hence, the possibility arises of producing important magnetic materials which may be easily magnetized in one direction, if we can arrange that the axes of the constituent crystals are aligned in a preferred direction.

This problem has been tackled in two ways. Thus, Swift Levick and Sons, Ltd., have produced the commercially available 'Columax', which is an improved grade of 'Alcomax III', in which the equiaxed crystals of the normal alloy are replaced by long columnar crystals in a preferred direction parallel to the direction of magnetization determined during heat treatment in an applied field. The new magnets must always be in the form of simple solid cylinders or rectangular blocks, and cannot be provided with cored or drilled holes; but, of course, this does not preclude their use in many assemblies and iron circuits. Their maximum remanence is about 13,000 gauss and their coercivity between 700 and 740 oersteds. The quantity $(BH)_{max.}$, which is a criterion of suitability as a permanent magnet material, is of the order $6{\cdot}8 \times 10^6$ gauss-oersteds.

A second way consists in making magnets of compressed manganese bismuthide powder[3] (MnBi). Single crystals of manganese bismuthide are hexagonal and have properties resembling those of hexagonal cobalt, but the material has very high magnetic anisotropy and so possesses a very high coercivity; in fact, values of coercivity measured from an I,H curve as high as 12,000 oersteds have been recorded, which would mean that the coercivity as measured from a B,H curve, as normally specified by a manufacturer of permanent magnets, might be of the order of 7,000 oersteds. It would be surprising, however, if stable permanent magnets of a material as brittle as manganese bismuthide, with a Curie point around 350° C., could be prepared as conveniently as those described earlier.

In addition to the above materials, we also have on the market a material of high coercivity which is virtually a Heusler alloy in which the copper in the well-known aluminium–copper–manganese alloy is replaced by silver. Another important new development[4] in powder metallurgy is the production of the materials known under the trade name of 'Ferroxdure', which consist of blocks of compressed oxides of iron and barium. These have coercivities of the order 1,450 oersteds with a value of $(BH)_{max.}$ of about $0{\cdot}85 \times 10^6$ gauss-oersteds.

Naturally, all such materials are of considerable interest because of the special uses to which they may be put by persons of ingenuity.

[1] Bates, L. F., "Modern Magnetism", 443 (Cambridge, 1951).
[2] Stoner, E. C., and Wohlfarth, E. P., *Phil. Trans. Roy. Soc.*, A, **240**, 599 (1948).
[3] Adam, E., *Rev. Mod. Phys.*, **25**, 306 (1953).
[4] Went, J. J., *et al.*, *Philips Tech. Rev.*, **13**, 194 (1952).

ACOUSTIC DESIGN OF AUDITORIA*

By P. H. PARKIN and W. A. ALLEN
Building Research Station, Garston

MODERN building acoustics is based on the work of Prof. W. C. Sabine, of Harvard University. At the end of the past century, Sabine defined and measured reverberation time (the period taken for sound in an enclosure to decay by 60 decibels), and established the simple relationship that this time is directly proportional to the volume of the room and inversely proportional to the quantity of sound absorbent present in the room. After this major advance, comparatively little further progress was made until after the First World War when the rapid development of broadcasting and sound films caused a corresponding development of apparatus suitable for making acoustical measurements. After a short period of optimism, when it was thought that the way was now open to the design of perfect auditoria, this new apparatus served mainly to demonstrate the complexity of the problem; the result is that to-day—after twenty years of accurate measurements—we can only claim that auditoria can be designed to avoid major faults such as echoes, but cannot be designed to obtain with any certainty the more positive requirements such as, for concert halls, fullness of tone.

This slow rate of progress is due to three causes. First, sound is a wave motion: the detailed behaviour of a three-dimensional sound field is complicated by the fact that the wave-lengths of sound in air vary from twenty feet to one inch, while the dimensions of the objects which affect the waves are of the same order and are usually such inconvenient materials as wood, textiles or human bodies; further, nearly all sounds are transient. Secondly, the final judge of the acoustical quality of a room is the human ear, which has several remarkable properties, most of which are not yet fully understood. Thirdly, the full-scale experiments possible are limited by the practical difficulties, not least of which is the expense of even the smallest alteration to the interior of a large room. (An exception to the slow rate of progress has been the rapid development during the past few years of knowledge about speech reinforcement systems. Microphones, amplifiers and loudspeakers were all technically excellent when the work of Haas[1], referred to in more detail below, showed how this equipment should be used for giving the best acoustical results.) For similar reasons, we cannot expect a great deal of help in design from the complete theory of the behaviour of sound waves in rooms, but must rely on the simplified pictures of geometrical and statistical acoustics.

With these general considerations in mind, we can proceed to the design requirements for the two main types of auditoria: those for speech, and those for music. We deal here only with the larger auditoria. For speech this nowadays implies the use of a speech reinforcement system and will be illustrated by reference to the system designed for St. Paul's Cathedral[2]; for music the Royal Festival Hall, London, will serve as an example[3].

Both types of auditoria are the better for a low noise-level; but with a speech reinforcement system this requirement is not so critical as it is for unaided speech or for music. It appears from the experience with the Festival Hall that a very low noise-level (of about twenty phons) is a positive advantage in that it enables an orchestra to play very quietly, thus, for example, increasing the artistic effect of crescendoes. From measurements of the noise-levels on a site and from the known sound-insulation values of most forms of construction, it is possible to design fairly accurately to get a given level of noise inside a building; greater accuracy, however, would be desirable when it is remembered that it is necessary to double the weight per unit area of a wall in order to increase the insulation by 5 db. In practice it is most important that the doors and windows (if any) should be suitably designed so that they do not nullify the insulation of the main structure, and the ventilation plant must also be carefully designed.

Dealing now with auditoria for music, the important musical requirements can be stated fairly definitely, at least in musical terms if not physically. They are fullness of tone, definition, blend, balance and no echoes. Taking them in reverse order, echoes can usually be avoided in the design or, failing this, can be eliminated in the completed building by suitable treatments of the offending areas. Balance, by which is meant the correct loudness ratios between the various sections of an orchestra, is partly a matter for the conductor, and the designer can be satisfied if he gives all the instruments an equal chance. This means in practice that the orchestral platform should be completely raked from front to back. Blend—the possibility of hearing an orchestra as a homogeneous source—is not entirely dependent on the acoustics, but is probably best helped by having surfaces close to the orchestra which reflect some of the sound directly back to the orchestra.

The first two musical requirements—fullness of tone, and definition (and their many synonyms)—present the worst problems to the designer. Fullness is difficult to define, even in musical terms, although it is easily recognized; all we can say is that it is the satisfactory quality added to the sounds produced by musical instruments when in a concert hall as compared with them in the open air. We cannot say for certain what acoustical factors control this quality; the only factor we have under any control is the reverberation, and the most reasonable supposition is that, when designing a concert hall, the longer the reverberation time can be made the more chance there is of obtaining adequate fullness of tone.

Definition has two main characteristics: the first is concerned with hearing the full timbre of each instrument; the second is concerned with hearing every note distinctly so that, for example, it is possible to hear all the separate notes in a very rapid passage. This quality is obtained when the intensity of the direct sound reaching the listener from the source is greater than the intensity of the reverberant sound. The intensity of the direct sound will vary from the front to the back of a hall due to two factors: the first is the usual inverse square law, and in a large hall the difference in intensity between the front and back rows will be of the order of 20 db.; the second is the absorption of the direct sound as it passes over the audience at grazing incidence, although this can be minimized by raking the audience seating. However, it appears that definition can be maintained if the true direct sound is followed shortly after by strong reflexions, and thus a reflector should be suitably placed close to the orchestra to reflect

* Based on a course of three lectures given at the Royal Institution on November 25, December 2 and 9. The course dealt with the larger types of auditoria, but not film or broadcasting studios.

sound towards the rear of the hall. This method has been successful in the Festival Hall, where the reflector suspended over the orchestra (and which weighs 12 tons) has maintained the definition over the whole auditorium.

Although these main criteria for the design of a concert hall can now be regarded as fairly well established, they are, except for reverberation time, all qualitative in character, and there is an obvious need for much more quantitative work.

Turning now to design problems for speech in auditoria, we are on more solid ground. The major single advance in recent years has been the work of Haas[1], who investigated the effect of a single echo on the audibility of speech. Extensions of his work made possible a quite reliable criterion[4] for the transient response of an auditorium. This criterion indicates how a room shape should be designed to ensure that the reflected and reverberant sound gives the maximum intelligibility and naturalness, although there is still need for far more knowledge on the actual behaviour of rooms.

But it is in its application to speech reinforcement systems that the Haas work has so far proved most useful, in two ways. First, a single echo (that is, a delayed reproduction of the original sound, usually coming from a different direction) when delayed behind the original sound by 5–25 msec. has to be about 10 db. greater in intensity to be heard as loudly as the original sound, and at lesser intensities is not detectable as a separate source; secondly, at greater time-delays, Haas determined how loud such an echo can be before it begins to interfere with the speech. For example, an echo of intensity 3 db. lower than that of the original sound is not heard as an obtrusive echo until it is more than 60 msec. behind the original sound.

The applications to speech reinforcement systems are obvious. In a simple system employing only one loudspeaker, this loudspeaker should be placed so that the sound from it arrives 5–25 msec. after the sound from the human speaker. The loudspeaker sound can then be up to, say, 7 db. greater than the original sound without being heard as a separate source. In large auditoria where a single loudspeaker is not sufficient, the same effect can be maintained by using electrical delays. Thus in St. Paul's Cathedral the loudspeakers installed down the nave are delayed by time intervals corresponding to the path differences between the pulpit and the listener plus 5–25 msec., so that all the sound appears to be coming from the pulpit. The second Haas result can be used to ensure (by suitable directivity of the loudspeakers) that the sound travelling back towards the source is at a sufficiently low intensity to avoid interference.

An interesting further application of this work, although not yet tried in practice, would be in debating chambers and other similar auditoria where the original sound might come from anywhere in the floor area. Thus we can envisage a rectangular chamber split into a number of zones each with its own microphone and loudspeaker. When speech is coming from one zone, the loudspeakers in all other zones are automatically switched to have the proper time delays and amplitudes so that the sound received at any point conforms to the Haas criteria.

One more development in speech reinforcement systems should be mentioned. It has been noted that to maintain intelligibility in the presence of reverberation it is necessary for the intensity of the direct sound to be greater than that of the reverberant sound. Now, with an ordinary loudspeaker radiating more-or-less equally in all directions, the intensity of the direct sound has fallen, due to the inverse square law, below the intensity of the reverberant sound at quite a short distance away. But if we use a directional loudspeaker so that most of the energy is radiated towards the listeners, although, of course, the inverse square law still operates, the intensity of the reverberant sound is so much less that the loudspeaker is effective over a greater distance. This is most conveniently done using a vertical line-source which in the vertical plane is sharply directional, producing a main lobe perpendicular to the line and several subsidiary, negligible lobes. At St. Paul's such a line source, 11 ft. long, placed close to the pulpit is effective over the whole dome area (110 ft. in diameter) in spite of the very long reverberation time.

In conclusion, reverting to concert halls, as our knowledge of the desirable acoustical characteristics increases it may become possible to use electronic aids for music as well as speech. For example, in any large modern concert hall it is difficult to get a long enough reverberation time (by having a large volume and a small amount of absorption) without the risk of serious echoes. It might be possible to introduce artificial reverberation by electronic means which would be indistinguishable from natural reverberation and which, possibly, could be altered to suit the particular type of music being played. But this development is some way in the future.

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[1] Haas, H., *Acustica*, **1**, 2 (1951).
[2] Parkin, P. H., and Taylor, P. H., *Wireless World*, **58**, 2 and 3 (1952); see also *Nature*, **169**, 214 (1952).
[3] Parkin, P. H., and Allen, W. A., Purkis, H. J., and Scholes, W. E., *Acustica*, **3**, 1 (1953); see also *Nature*, **168**, 264 (1951).
[4] Doak, P. E., and Bolt, R. H., *J. Acoust. Soc. America*, **22**, 4 (1950).

OBITUARY

Dr. C. E. Walker

Dr. Charles Edward Walker died at his home in Brighton on June 6 at the age of eighty-two. He was educated at St. George's College, Weybridge, and studied medicine at St. George's Hospital, London, where he was assistant medical registrar; he qualified M.R.C.S., L.R.C.P. London, in 1909. After holding a demonstratorship in zoology at the Royal College of Science, South Kensington, he went to Liverpool as assistant director of cancer research and honorary lecturer in cytology to the Liverpool School of Tropical Medicine. He obtained the degree of M.Sc. Liverpool in 1909, and of D.Sc. in 1911; afterwards he went to Glasgow as director of research at the Royal Cancer Hospital. Dr. Walker served in the R.A.M.C. with the rank of major in the First World War in France, Gallipoli and the Middle East. He returned to the University of Liverpool in 1919 as lecturer in histology and associate professor of cytology. He held this appointment until his retirement in 1937.

Dr. Walker's work, largely cytological, was published mainly in the form of contributions to the *Proceedings of the Royal Society*. He was also the author of several books on cytology, heredity, evolution, and the cancer problem. The present revival of interest in the Golgi apparatus naturally recalls his contributions to the subject. He was among the first, twenty-five years ago, to carry out

deliberate experiments concerned with the importance of physico-chemical fixation artefacts in the usual tissue sections. His experiments were done with chemical models, employing microscope slides coated with films of mixtures of albumin, lecithin, peptone, together with olive oil and ground egg yolk. The slides were fixed and stained by procedures normally employed for the demonstration of the Golgi apparatus in tissue sections. Structures bearing a striking resemblance to the classical Golgi net were obtained, which led Walker to doubt the existence of the apparatus in the living cell. This work laid the foundations for the more recent investigations such as those of Palade and Claude.

Apart from his scientific publications, Dr. Walker was editor of *Shooting and Fishing* during 1897–1903, and author of "Shooting and Fishing on a Small Income". His tall upright figure, his monocle and his military bearing made him a notable figure in the medical school at Liverpool. His staff knew him as a courteous and kindly man. He skated and fenced. He was a skilful and intrepid yachtsman; in 1904 Mr. Justice Channell awarded him the Challenge Cup, the highest distinction of the Royal Cruising Club, for a single-handed cruise down channel to France and back in his 2-ton sloop *Thebe*.

His wife died last year and he is survived by a son and daughter. N. M. Hancox

NEWS and VIEWS

Physics in Queen Mary College, London: Prof. H. R. Robinson, F.R.S.

After having held the chair of physics at Queen Mary College, University of London, since 1930, Prof. H. R. Robinson is retiring at the end of the present session. His teaching and research work were greatly influenced by his association with Rutherford, first as a student and lecturer in the University of Manchester and later at Cambridge as the holder of the Moseley Research Studentship of the Royal Society. Prof. Robinson's scientific work has been largely concerned with radioactivity and X-rays. He developed with Rutherford the β-ray magnetic spectrometer, and has spent many years in the study of the application of X-ray methods to the elucidation of atomic structure and to the accurate determination of atomic constants. He has always had a special interest in the history of physics, which he regards as an essential part of the education of all serious physicists. During his long tenure of the chair of physics at Queen Mary College he has become well known to a wide circle through his services to the College and to the University of London. He became a member of the governing body of Queen Mary College in 1945 and vice-principal in 1946. He is a member of the Senate of the University of London and takes an active part in the work of several of its committees. He has also served on the Councils of the Royal Society and the Physical Society. His other interests are indicated by the fact that he has been for many years a member of the governing body of the Old Vic Theatre.

Dr. G. O. Jones

Dr. G. O. Jones, who is to succeed Prof. Robinson, has been reader in experimental physics at Queen Mary College since 1949. He graduated at Oxford in 1938 and worked under Sir John Townsend on high-frequency gas discharges and later at Sheffield under Prof. W. E. S. Turner on physical properties of glasses. He then joined Prof. F. E. Simon as a member of the U.K. Government atomic energy project, working mainly at the Clarendon Laboratory, Oxford, and also for short periods at the University of Birmingham and in the United States as a member of a Government mission. After the War, Dr. Jones was appointed as Nuffield Foundation Research Fellow at the Clarendon Laboratory under Prof. Simon. He prepared the detailed design and directed the construction of the large liquid-hydrogen plant serving the low-temperature department of the Laboratory. Later he worked on the properties of solid helium and of low-temperature glasses. During this period he was retained as a consultant by the Atomic Energy Research Establishment, Harwell. Since his appointment as reader at Queen Mary College, Dr. Jones has made new developments in the techniques of attaining low temperatures and has built up a research team working in the field of solid state and low-temperature physics. In this work high-pressure, magnetic, micro-wave and ultrasonic measurements are being employed in a number of investigations at temperatures down to those attainable with liquid helium. Dr. Jones is a member of the Papers Committee and also of the Low Temperature Group Committee of the Physical Society, and is a representative of the University of London on the governing body of the Sir John Cass College.

Mullard Research Laboratories

Mr. P. E. Trier and Mr. G. Knott have been appointed joint managers of the Mullard Research Laboratories. Mr. Trier, who graduated as a Wrangler in the Mathematical Tripos at Cambridge, was engaged at the Admiralty Signal and Radar Establishment during 1941–50. During the War he developed direction-finding techniques in the metre and centimetre regions. Later he was head of the V.H.F. Communications Group. He joined the Mullard Research Laboratories in 1950 as head of the Communications and Radar Division. In his present appointment, Mr. Trier will direct the Electronics Laboratory and be responsible for work in the fields of communications, radar, special circuit techniques, particle accelerators, special components and materials, valve applications, ultrasonics, and metal physics. Mr. Knott, sometime scholar of Clare College, Cambridge, commenced his career as physicist to the Calico Printers' Association in 1935. During 1937–40 he was engaged in research on X-ray crystallography in the University of Cambridge, and worked on molecular structure factors in relation to complex organic crystals. He is also the author of a number of publications on flash tubes and their use in high-speed photography. In 1940 Mr. Knott joined the Mullard Radio Valve Co., Ltd., first as development engineer on transmitting valves and later on V.H.F. valves. He was placed in charge of the Mullard Vacuum Physics Laboratory when it was formed in 1946. Mr. Knott will continue to direct the work of this laboratory in his new appointment, and will be responsible for V.H.F. valves, gas discharge tubes, and photo-electric devices.

General Electric Co., Ltd.

Mr. O. W. Humphreys and Mr. A. L. G. Lindley have been appointed to the board of directors of the General Electric Co., Ltd., London. Mr. Humphreys, who is director of the Research Laboratories of the Company at Wembley, Middlesex, joined the staff of the Laboratories in 1925, and in 1927 was appointed to its leading scientific staff in charge of the heat group. He is a vice-president of the Institute of Physics and of the Institution of Electrical Engineers. Mr. Lindley joined Fraser and Chalmers Engineering Works in 1918 as an apprentice, and after spending some years as an assistant engineer in the Mining Department was appointed in 1932 chief engineer of the British General Electric Co., Ltd., of South Africa. Returning to England in 1949, he became general manager of the Fraser and Chalmers Engineering Works.

British North Greenland Expedition

For the third year in succession, the Royal Air Force will undertake a series of flights within the Arctic Circle to assist the British North Greenland Expedition. This year's flights, which are required to carry stores for the Expedition, will be made in August by five Sunderland flying-boats of Coastal Command and two Hastings aircraft of Transport Command. On August 1, five Sunderlands of No. 201 Squadron will leave R.A.F. Station, Pembroke Dock, South Wales, for Greenland. Their base will be at Young Sound, on the north-east coast (lat. 74° 29′ N., long. 20° 40′ W.), to which the Expedition ship, the *Polarsirkel*, will deliver the stores. On August 5 the Sunderlands will start to fly seventy tons of stores to the Expedition's main camp at Britannia Lake (lat. 77° 07′ N., long. 23° 40′ W.), some 190 miles from Young Sound. The task should be completed in seven to ten days. In mid-August, two Hastings aircraft will leave R.A.F. Station, Abingdon, Berks, for the United States Air Force base at Thule, in north-western Greenland. Their task is to drop some sixty tons of supplies, chiefly petrol, for the 'weasel' tracked vehicles, to the existing advanced camp at position lat. 78° 02′ N., long. 37° 50′ W., now known as 'Northice', and also to establish a petrol dump in a position 200 miles to the west of Northice. The supply drops are due to start on August 20, and should be completed in about ten days; sugar, milk powder and miscellaneous items will also be dropped.

The Royal Air Force made the first flights for the British North Greenland Expedition in July 1951, when a preliminary survey of the ice-cap was made. In 1952, between August and October, five Sunderlands and two Hastings, with a total crew complement of 87 officers and airmen, carried 250 tons of equipment to help the Expedition establish bases. These air operations, apart from making an essential contribution to the success of the Expedition, proved of considerable training value to the R.A.F., since aircrews gained valuable experience in high-latitude navigation and cold-weather flying. The British North Greenland Expedition, of which the Queen is Patron, is undertaking a geophysical, geological and glaciological survey of hitherto unexplored areas of northern Greenland. One of the objects is to establish the depth of the great ice-cap which covers most of the country. The Expedition has now moved its 'weasels' over a glacier to the main base at Britannia Lake, and has relieved the original party of three which occupied the advanced camp at 'Northice'. The 'weasels' are now operating over the ice-cap, and the general field work of the Expedition is progressing according to plan.

Science in Education

In a speech before Timsbury County Secondary School on June 23, Prof. John Read, professor of chemistry in the University of St. Andrews, claimed that the teaching of mathematics and science should also train students to be exact, accurate, logically minded and precise in the expression of thought. The teaching of science should go still further in encouraging accurate observation and correct interpretation. The three main pillars of education, in spite of the present-day tendency to multiply subjects and introduce more work of a practical nature, are still the three R's: reading, in order to give good command of English; writing, to confer an ability to express ideas clearly and concisely; arithmetic, as the basis of a sound grounding in elementary mathematics. The ideal education should hold a proper balance between science and the arts. Science in itself contributes much to a cultural education. For example, it is difficult to consider a person as being properly educated or cultured who has no basic knowledge of what goes on in the world of Nature around him and also within himself. There are, of course, dangers in a purely scientific education in which a pupil may be overloaded with factual information or furnished with an account of the world which overlooks the moral aspect of the mind. There are plenty of reference libraries available, and this should be recognized together with Plutarch's dictum: "The child's mind is not a vessel to be filled, but a fire to be kindled". In brief, it must be realized that science has its limits as an educative and cultural instrument; but it must be acknowledged that to-day a certain broad acquaintance with science is essential in a world where science has such a profound influence on society and confers so much physical power on man.

Lighter Literature for the Medical Man

A Medical Bulletin, described as "a journal for the profession" and published by Messrs. May and Baker, Ltd., is a periodical different from most of the literature produced specifically for medical men's eyes and minds. Not all doctors will like all of it, but there is little doubt that many doctors must find in it relaxation and a lighter handling of serious subjects, which is often refreshing and sometimes both refreshing and instructive at the same time. It is possible, as several writers in this journal show, to write about grave matters with a disciplined sense of humour which, if it does not convey the facts of which the doctor sometimes gets too many, illuminates the subject from unusual points of view, so that new and instructive aspects of it become evident. This, however, is a difficult art. It is so easy to do no more than reproduce a manner of writing too reminiscent of the medical students' magazines to which many of the adult readers of this *Bulletin* probably contributed. The *Bulletin* also contains some interesting and attractively written articles which are not specifically medical. Those, for example, on the development of the small house in England, which are so charmingly illustrated, would win the heart of any reader or editor; and in the series on the doctor's helpmates, the doctor's wife, who does so much and gets so little public regard,

receives the honour which has always been her due. An interesting note on spontaneous combustion, of which 150 cases have been recorded, points a finger at gin and reminds us that Marryat was not romancing when he let poor Jacob Faithful see his mother end this way. Besprinkled with illustrations and with light and often entertaining verse, this *Bulletin* will, we hope, live on to lighten the strain of the busy practitioner's life.

Coconut Milk Growth Factor

That the watery endosperm of the coconut contains the growth-promoting 'coconut-milk factor' at all stages of development has been shown by F. C. Steward and S. M. Caplin (*Ann. Bot.*, N.S., **16**, 64; 1952). Some activity is also shown by parts of the immature embryo but not by the solid endosperm. Growth-promoting substances of analogous activity have been detected in the immature milky endosperm of maize, in the gelatinous material in immature walnut fruits, and in the young gametophyte of *Ginkgo biloba*. The tissues from which these substances have been obtained appear to grow at the expense of, or to be nourished by, the nucellar tissue. In *Cocos* (coconut), *Zea* (maize) and *Juglans* (walnut) it is the immature embryo that eventually benefits from the growth factor. The conditions that are conducive to the accumulation of the substance seem to involve, or to be associated with, a delay in the growth of the embryo but a precocious formation of the endosperm.

Optics and Microwaves: Conference in Milan

A conference on "Optics and Microwaves" was held in Milan during June 9–11, 1952, under the auspices of Unesco, the International Union of Pure and Applied Physics, the Consiglio Nazionale delle Ricerche, the Commissione Nazionale Italiana per l'Ottica, and the Società Italiana di Fisica. A special supplement of *Nuovo Cimento* containing the proceedings of this conference has now been published (Supp. 3 to Vol. 9, Ser. 9; 1952. 2,500 lire). It includes the twenty-seven original communications presented and discussed at the conference and a summary of the work of the conference, written by Prof. R. Malvano, of Turin; a very full account of the discussion is also given. Two of the main subjects treated are the spectroscopy and polarimetry of radiations from infra-red to microwaves; the phenomena of diffraction and propagation (including all the problems relating to the resolving power and to the antenna radiation pattern). Among the most important contributions reported are the following: a microwave spectroscope for the 1·25-cm. wave region (J. C. van den Bosch and F. Bruin); measurement of the velocity of electromagnetic waves and the refractive index of air at microwave frequencies (L. Essen and K. D. Froome); experimental demonstration of microwaves and their optical analogues (G. F. Hull, jun.); applications de la géométrie différentielle à l'optique des microondes (K. S. Kunz); spectroscopy near the boundary between the microwave and infra-red regions (A. H. Nethercot, J. A. Klein, J. H. N. Loubser and C. H. Townes); methods of light optics for the calculation of the diffraction phenomena within the range of centimetre waves (H. Severin); une optique correctrice pour les projecteurs d'onde U.H.F. (J. C. Simon); super-gain antennæ and optical resolving power (G. Toraldo di Francia); and theory and applications of surface waves (F. J. Zucker).

Seminar on Polymer Science

As a continuation of an earlier seminar (see *Nature*, **171**, 65; 1953) four lectures were given in the Chemistry Department in University College, London, on June 29. Prof. H. F. Mark described the preparation and properties of co-polymers containing long stretches of monomer units in one single macromolecule. If one stretch of the monomer unit is water-soluble and another stretch of different monomer units is oil-soluble, solutions of the resulting co-polymer have interesting colloid chemical properties. Samples of such co-polymers were demonstrated. Further work discussed by Mark dealt with the structure of polythenes, with the determination of the molecular weight distribution of polymers by a novel method developed by Debye, and with the influence of stress on swelling; the latter effect being demonstrated by a lecture experiment. Dr. C. W. Bunn discussed melting points of chain polymers, and Dr. L. R. G. Treloar outlined the type of conclusions which can be derived from a study of photo-elastic effects of polymers. He showed that in certain cases the stress optical coefficient is a specific molecular quantity which can be used to estimate the length of a statistical chain element. This lecture included demonstrations of photo-elastic effects in crystalline and amorphous polymers. Dr. K. Bailey dealt with certain properties of filamentous muscle proteins. He showed that the rotational relaxation times of these polyampholytes can be estimated by Weber's method (involving the measurement of the polarization of fluorescent light), and he reported results showing in which way these relaxation times are affected by chemical conditions. Each lecture was followed by a discussion which was facilitated by circulating short abstracts in advance.

United States National Science Foundation: Fellowship Awards and Research Grants

For the academic year 1953–54 the United States National Science Foundation has awarded 556 graduate fellowships in the natural sciences out of 3,298 applications from all parts of the continental United States, Hawaii and Puerto Rico; in addition, 1,274 applicants were given an 'honorable mention'. 515 awards were made to graduates studying for doctorates (180 first year, 166 intermediate and 169 final year) and 41 to post-doctorate students. The fellowships are awarded on the basis of academic record and recommendations and, in addition, the pre-doctorate students were required to take examinations; in cases of substantially equal merit, the choice was made so as to result in a wide geographical distribution. The list includes 175 awards to those already holding Foundation fellowships, though for the new awards they had to compete afresh. The distribution by subjects is as follows: chemistry, 129; physics, 115; engineering, 63; mathematics, 56; zoology, 38; biochemistry, 35; geosciences, 26; botany, 19; microbiology, 18; biophysics, 14; medical sciences, 13; genetics, 11; psychology and anthropology, 10; and agriculture, 9. Fellows may study at any non-profit institution of higher education in the United States or, subject to approval, abroad. The stipends are 1,400–1,800 dollars for pre-doctorate students and 3,400 dollars for those holding doctorates. The Foundation has also announced the award of sixty grants, totalling 469,550 dollars, to institutions in the United States for the support of studies and conferences on science and scientific education. This is the third group of awards for the fiscal year

1953 and brings the total for the year to 190 grants worth 1,810,200 dollars. The fields covered are astronomy, chemistry, developmental biology, earth sciences, engineering, genetic biology, mathematics, molecular biology, physics, psychobiology, regulatory biology, research education in the sciences, scientific information, studies in science, and systematic biology. The grants range from six months to three years, with an average length of 1·6 years.

Subject Index of British Patent Specifications

Because of war-time difficulties, the printing of subject indexes to British patent specifications since 1939 (Nos. 500,001 onwards) had fallen badly into arrears. Good progress has recently been made in reducing these arrears, but their complete elimination is unlikely to be achieved in less than two years. Meanwhile, searches continue to be difficult and costly. The Patent Office has now permitted Aslib to make 35-mm. microfilm copies of the Patent Office's own Press Mark Indexes and to make them universally available. The Press Mark Index—which will be in most cases the only subject index available in respect of 1939–53 (April 30)—is a fourteen-year cumulative list of the 271 patent classes showing the numbers of the patents in each and their allocation to sub-classes. Microfilm copies of the Index (nearly 8,000 pages) are now available, price £10 10*s*., from the Director, Aslib, 4 Palace Gate, London, W.8.

Eleventh Conference of the International Federation of University Women

The eleventh conference of the International Federation of University Women will be held in London at Bedford College during August 6–13, with the British Federation of University Women acting as the host body. More than five hundred representatives from the thirty-one countries affiliated to the International Federation have arranged to attend. A large part of the conference programme will be devoted to business meetings at which the affairs of the International Federation will be discussed and arranged. The Federation is responsible for the award of international research fellowships, seventy-eight having been awarded since its foundation to scholars of twenty-four countries; for furthering the interests of professional women; for the development of cultural relations between members of the Federation in different countries; and for helping displaced university women, of whom there are still large numbers, especially among the elderly. In addition to the business meetings, it is the custom of these conferences to choose a special subject to be considered at a number of public lectures and group discussions; the theme this year is "Human Values in the Technical World", and the conference will open with an inaugural lecture by Sir Henry Self on "London Town", which will deal with the part London has played as a focal point of technical development within the wider field of scientific and humanistic thought. The enrolment fee for the conference is £3 and application forms can be obtained from the Conference Secretary, I.F.U.W. Headquarters, 1 Sedding Street, Sloane Square, London, S.W.1.

Toronto Meteorological Conference

The American Meteorological Society and the Royal Meteorological Societies are to hold a joint meeting in Toronto during September 9–15; the Canadian Branch of the Royal Meteorological Society will be responsible for the local arrangements. The meeting has been made possible by the generosity of the Munitalp Foundation in America, which has made a substantial grant available to both Societies with the view of promoting co-operation and goodwill between them. The programme includes symposia and discussion on the following subjects: ozone and the high atmosphere; cloud physics and induced precipitation; modern cyclone theory; arctic meteorology; radiation; climatic change; microclimatology; high-level forecasting; general circulation. This will be the first occasion upon which the two Societies have arranged a joint meeting.

Announcements

Mr. L. G. Melville has been appointed vice-chancellor of the Australian National University, Canberra, in succession to Sir Douglas Copland, who has recently assumed office as High Commissioner for Australia in Ottawa. Mr. Melville is Australian Executive Director of the International Bank for Reconstruction and Development and the International Monetary Fund in Washington; he is a distinguished economist, who was formerly professor of economics in the University of Adelaide.

Dr. Carey Croneis has been appointed provost and Harry Carothers Wiess professor of geology in the Rice Institute, Houston, Texas. Dr. Croneis, who will take up his new office in January, was born in Bucyrus, Ohio, in 1901, and holds degrees of Denison, Kansas and Harvard Universities. During 1928–44 he was a member of the geology faculty of the University of Chicago and since 1944 has been president of Beloit College.

The following appointments in the University of London have been announced: Dr. W. St. C. Symmers, senior lecturer in the University of Birmingham, to the University chair of morbid anatomy tenable at Charing Cross Hospital Medical School; Dr. J. H. F. Brotherston, senior lecturer in public health at the London School of Hygiene and Tropical Medicine, to the University readership in public health tenable at that School.

The following appointments in the University of Nottingham have been announced: Dr. Rodney Hill, Research Fellow in theoretical mechanics in the University of Bristol, to the newly established chair of applied mathematics from October 1; Dr. K. W. H. Stevens, Research Fellow in theoretical physics in the University of Oxford, to be reader in theoretical physics from October 1.

Ramsay Memorial Fellowships for research in chemistry have been awarded for 1953–54 to the following: Mr. G. T. Rogers, a British Fellowship of £500 a year in the University of Cambridge; Mr. B. I. Parsons, a Canadian Fellowship in the University of Oxford; Mr. Santos Amer, a Spanish Fellowship in the University of Bristol; Mr. Gines Guzman, a Spanish Fellowship in the University of Oxford; Mr. R. H. Doremus, a United States Fellowship in the University of Cambridge. British Fellowships held by Dr. G. H. R. Summers (Cambridge) and Dr. R. F. Webb (Cambridge) have been renewed for 1953–54.

Work in progress at the Chemical Research Laboratory, Teddington, will be demonstrated at a series of open days during September 22–25. Applications from industrial firms for invitations to the sessions should be sent to the Director before August 31.

BIRBAL SAHNI INSTITUTE OF PALÆOBOTANY, LUCKNOW

By Dr. OVE ARBO HOEG
Director

THE Birbal Sahni Institute of Palæobotany in Lucknow was founded on the initiative of Prof. Birbal Sahni, whose sudden death, on April 10, 1949, caused grief to his many friends and colleagues all over the world. It happened only one week after the foundation stone for the new Institute building had been laid by Mr. Nehru, the Prime Minister of India. This tragic occurrence threatened the existence of the Institute at its very start, and it was only due to the untiring work of Mrs. Savitri Sahni, with the help and co-operation of Sahni's collaborators, and to the sympathetic interest of the Government, particularly Sir S. S. Bhatnagar, that the Institute survived the difficult period which followed.

When founded in 1946 the Institute had at its disposal a nucleus of funds donated by Prof. and Mrs. Sahni and by the Burmah Oil Company, together with Prof. Sahni's collection of fossil plants and his palæobotanical library, also donated for the purpose. The Government of Uttar Pradesh gave the necessary land for the new building, together with various grants. But the main burden has been borne by the Government of India, which, until the end of the financial year 1952–53, has given non-recurring grants for the building and furniture to the amount of Rs. 652,800 and an annual recurring grant which in recent years has been Rs. 150,000. During 1951–53 Unesco, under its Technical Assistance Programme, has helped the Institute by providing a director, a scholarship, and grants for equipment.

The new building was opened officially by Mr. Nehru on January 2, 1953. It was designed by Messrs. A. P. Kanvinde and Shaukat Rai, architects to the Council of Scientific and Industrial Research. It is in two stories; but on the first floor only the front row of rooms has been built. From an architectural point of view it differs from the traditional Indian style in so far as there are no broad verandas along the front. Instead, it has vertical louvres on the south side, which act as sun-breakers, so that during summer no direct rays can fall on the windows.

The total length of the building is 271 ft. There is a 9-ft. corridor along the centre of the building, with laboratories and other rooms on both sides. The window axes are 12 ft. apart, so that, depending on the position of the partitions, there are laboratories approximately 12, 24 or 36 ft. by 22 ft. In all laboratories there are benches along the outer wall, with all service pipes concealed behind the benches. The Institute has its own small petrol-gas plant with connexions to all the laboratories.

The basement comprises workshops and store-rooms. The workshops are well equipped with cutting and polishing machines, bandsaws, etc. In the main store-room for the fossil collection there are racks with interchangeable drawers; the racks have doors and cylindrical dust-traps with cotton wool. Similar smaller racks, for the same kind of drawers, are placed in the laboratories for keeping the specimens which are being studied there.

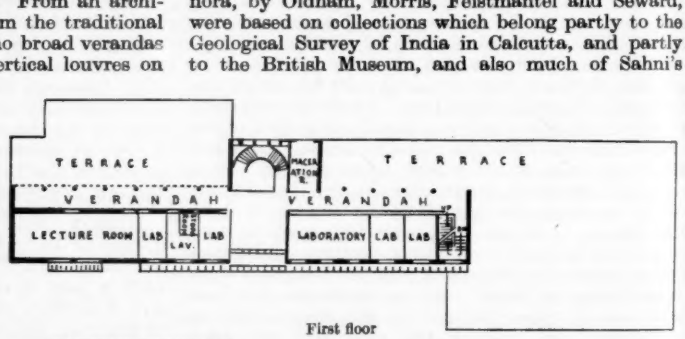
The ground floor, in addition to laboratories and offices, accommodates two large museum halls with a permanent exhibition, and a library, of which a part is provided with a mezzanine floor. There are two darkrooms, one of them air-conditioned.

On the first floor there are laboratories, including a special maceration room with fume-chambers, and a lecture theatre with eighty seats.

The library of the Institute has as its main core Prof. Sahni's collection of reprints and other palæobotanical literature which he acquired over many years by exchange, gift or purchase, and which after his death has been augmented by the same means. Altogether the library comprises approximately 9,500 reprints, 600 books and 500 volumes of journals. The reprints are stored horizontally on shelves in steel *almirahs*. This method requires more space than the usual vertical arrangement in boxes, but has considerable advantages: the reprints do not bend, they are easily taken out because they are placed in each shelf on a plate of cardboard with a tab hanging down in front, and quarto and octavo sizes can be kept together.

The Institute is publishing a journal, *The Palæobotanist*, of which the first volume was sent out in 1952 as a "Sahni Memorial Volume" (533 pages, 79 plates), and the second volume will appear this year. It is planned that as a rule there will be one volume per year.

The first classical descriptions of the Indian fossil flora, by Oldham, Morris, Feistmantel and Seward, were based on collections which belong partly to the Geological Survey of India in Calcutta, and partly to the British Museum, and also much of Sahni's



Birbal Sahni Institute, Lucknow

work was based on collections belonging to the Geological Survey of India. The collections in the Institute comprise those brought together by Prof. Sahni and his pupils in various parts of India, and others donated by institutions and colleagues abroad. They include many type specimens and other material described by Sahni and other members of the staff, and they are rapidly increasing, thanks to the field activities which play an important part in the Institute's programme.

The scientific staff of the Institute consists at present of the director (Dr. O. A. Hoeg), two assistant directors (Dr. R. V. Sitholey and Dr. K. R. Surange), one senior scientific officer (post vacant), three junior scientific officers (lecturers), and a number of research scholars and research assistants. Nine scholarships have been granted by the Governments of India and of Uttar Pradesh and by the Assam Oil Company (Burmah Oil Co.). The scholars work on a wide variety of problems, most of them with the intention of submitting theses for the degree of Ph.D. at one of the Indian universities by which the Institute has been recognized.

The Council of Scientific and Industrial Research has sponsored three research schemes in the Institute, each scheme with two research assistants appointed by the Council and a senior member of the scientific staff as supervisor.

The administrative and clerical staff is quite considerable, and in addition there are an artist, a photographer, a mechanic, two section-cutters, and other assistant staff.

The scope of the Institute is to promote palæobotanical research in all its aspects, on an Indian, as well as international, basis. Necessarily, the study of Indian fossil floras will always form the main object of the activity.

Apart from a very few and poorly preserved plant remains from older periods, the oldest flora in India is the Lower Gondwana flora, with *Glossopteris*, etc., connected with the most important coalfields in India. From the younger periods there is an extremely interesting Jurassic flora, mostly in an excellent state of petrification, in the Rajmahal Hills in Bihar, and there are remains of flowering plants, in equally good preservation, in the Deccan Intertrappean of early Eocene age. In addition, there are fossil plants in other places and from different ages. Research on a variety of such material is being carried out in the Institute.

In recent years microfossils, particularly pollen grains and spores, have become more and more important in palæobotany. It happens that they are preserved in great numbers in sediments where macrofossils are few or entirely missing, and they may therefore help to solve age problems in cases where other fossils have failed. It was in recognition of this fact that Prof. Sahni planned a search for microfossils in Indian sedimentary rocks containing no macrofossils and the age of which is uncertain. The plan received the support of the Council of Scientific and Industrial Research in 1947 and is still going on in the Institute.

Peat bogs and lake deposits with an abundance of pollen, like those of north-west Europe, are unknown in India, but even so there are some possibilities of pollen analysis of Pleistocene and older sediments, for example, in clays in Kashmir, some of which have proved to be rich in pollen, and possibly also in the plains. Until now, practically nothing has been known about pollen production of trees and other plants in India; such knowledge forms part of the basis for pollen analysis, and the Institute therefore, in 1952, started an investigation of the pollen in the air at Lucknow. With the support of the C.S.I.R., palynological studies on a broader basis, and a pollen herbarium are now being started.

In 1952 the Institute, again with the support of the C.S.I.R., and in co-operation with the Fuel Research Institute, was able to start another research scheme, the palæobotanical investigation of Indian coals. Studies on microfossils in Indian coals have been going on in the Institute since 1949; but under the new scheme it is possible to give the work a broader basis and a wider scope. The work so far has been concentrated on analysing the contents of spores and pollen in various seams. When a sufficiently detailed knowledge has been gained of the various spore forms and their distribution it will be of interest to ascertain to what extent this knowledge can be used for correlation of coal seams. Such practical utilization has proved to be of considerable value in other countries and has also already in a few cases been tried with success in India.

Prof. Sahni himself scarcely had any higher wish for the Institute than that it should be regarded by every palæobotanist as a home and as a place where scientists, from all parts of the world, could come for research and exchange of ideas. He did not live to see that happen. Now, however, the Institute is established, its doors are open, and palæobotanists are welcome to fulfil the wish of its great founder.

NATURE OF VIRUSES

THE Society for Visiting Scientists is to be congratulated on holding yet another successful informal symposium—this time on the "Nature and Constitution of Viruses". A crowded meeting on May 5, under the chairmanship of Dr. A. S. McFarlane, listened to opening contributions from three leading international authorities in this field.

Dr. P. R. Lépine described the work going on at the Pasteur Institute, Paris, in the study of virus inclusion bodies. He adopted a predominantly morphological approach illustrated by electron micrographs of inclusions seen in rabbit myxoma (which is prevalent at present in France), fowl pox and rabies. He discussed the different types, noting particularly that some appear to consist solely of aggregates of elementary virus particles, whereas others are not uniform in composition. An extreme case of the latter is to be seen in the intracellular polyhedra which characterize some insect virus infections and which contain only a few per cent of virus. Generally, small virus forms or signs of virus particles about to divide were absent from his pictures.

Dr. R. W. G. Wyckoff (United States) also showed some striking electron micrographs, mainly of ultra-thin tissue sections. In the chick chorio-allantoic membrane infected with influenza virus, rods and spheres can be seen at the periphery of infected cells having the dimensions and general appearance of the round and filamentous forms of the virus. The rods show definite indications of originating as finger-like protrusions of the cytoplasm of the host cell, and the spheres appear to originate by fragmentation of the rods. No rods or spheres can be seen inside the infected cells. Rous virus in tissue culture showed no cytoplasmic protrusions of the host cell; but

pockets of elementary virus particles are present in the cytoplasm—not unlike some of the inclusions shown by Dr. Lépine. Vaccinia-infected chorio-allantoic membrane, on the other hand, shows some peripheral protrusions in addition to the characteristic brick-shaped particles inside the infected cells. Early in the course of infection a few virus particles are present; but again no small or dividing forms can be seen. In a few cases, chains of particles of standard size can be seen. Pictures of bacteriophage suggest the separate formation of tails and empty heads at an early stage in 'phage production. These appear to arise *de novo* in the host cytoplasm, that is, unassociated with parent particles.

Mr. F. C. Bawden (Harpenden) defined virus as a name for the cause of a transmissible disease with no visible cause. What is studied in the laboratory is a fraction which contains the maximal infectivity in the minimal of chemical substance. In the 1930's the study of the plant viruses was carried out mainly by chemical isolations. Twelve viruses have been isolated in a state of homogeneity, and in pure chemical form all are ribonucleoproteins. They differ among themselves in the ratio of protein to nucleic acid, and electron microscopy has shown differences in morphology. The nucleoprotein appears to be the essential multiplying portion of the virus; but in studying chemically purified fractions it is well to remember that much may have been lost in the purification processes. He reminded the audience, in this connexion, that the removal of a rabbit's ear or tail would be unlikely to affect its reproductive activity.

Mr. Bawden referred to the dark period following infection, when little or no virus is detectable in the cells, and which led him to favour the hypothesis that the virus changes the genetic character of its host. In the course of infection a number of other types of particle are produced besides virus; these have been variously named 'incomplete virus', soluble antigens, etc. No kind of particle has been shown to be the forerunner of any other type, and Mr. Bawden thought it was asking a lot of Nature to turn out millions of particles identical with one another.

In the lively discussion which followed, a great deal of interest was shown in the recent demonstration by Hershey and Chase that, following infection by bacteriophage, the protein shell of the infecting 'phage remains outside the infected bacterial cell, while the nucleic acid enters and is able to initiate virus production even if the protein shells are removed by shearing forces. Dr. R. Markham, in particular, said he was mystified as to how 'phage nucleic acid got into and out of its protein shell and whether the results would apply to other viruses. In a meeting where many interesting points were discussed, this topic seemed to appeal most to the general imagination.

Prof. S. P. Bedson pointed to an inconsistency in the argument about how viruses multiply. It is generally conceded that the rickettsiæ and the organisms (? viruses) of the psittacosis group multiply by binary fission; but a different form of multiplication is postulated for the smaller viruses. The main argument in favour of this hypothesis is that following infection of cells by one of the smaller viruses, there is a latent period during which little or no virus can be detected in the cells, followed by a sudden increase in the amount of detectable virus. However, recent experimental work indicates that organisms of the psittacosis group, large viruses such as those of myxoma and vaccinia, and indeed all viruses which have been studied, show a similar type of growth curve. Prof. Bedson argued that if psittacosis organisms multiplied by binary fission, there was no real reason why smaller viruses should not do so also, and the speakers were not prepared to dispute his argument.

Prof. Wilson Smith was sceptical of generalizations in the field of viruses and put forward some experimental evidence with the proviso that, so far as he knew, it applied to influenza virus and nothing else. In general, his evidence lent support to Dr. Wyckoff's view that the virus incorporated some part of the host cytoplasm in it. Heat-treated influenza *A* virus crosses serologically with the *B* virus, and the implication is that both forms have something in common derived from the host, or are contaminated by host protein. On the whole he favoured the former. Mr. Bawden countered with the statement that "one man's impurity is very often another man's biologically important product".

Dr. B. Stocker described the work of Zinder and Lederberg on 'phage transduction as supporting Wilson Smith's hypothesis. He pointed out that the factor which is transduced does not appear to be superficially situated on the transducing 'phage. He also described the behaviour of lysogenic 'phage as evidence that 'phage could be transmitted through different generations of bacteria in the complete absence of the usual structural characteristics.

Dr. A. Isaacs objected to the term fragments of cytoplasm when applied to viruses, and Bawden supported this and pointed to a competition between the cell and the virus for essential constituents.

Dr. McFarlane, in summing up, noted that a major part of the evening had been devoted to considerations of the influence of the host cell on the nature and constitution of the virus. This spontaneous trend, he said, suggests that the matter is of prime importance. Some speakers were prepared to go so far as to say that virus particles are shaped out of pieces of host cytoplasm—possibly out of whole genetic units—while others would only say that molecules with the specific antigenic configuration of the host are incorporated into viruses. A less vocal section of the audience appeared to resent these views and could see few grounds for believing that infecting virus particles did more than borrow some biochemical mechanisms from the host and get on with the job of self-duplication. Dr. McFarlane also remarked on the fact that the crystallographers present were prepared to confer 'crystal' status on the insect polyhedral bodies although these contained only a few per cent of virus. It seemed, therefore, that after crystals are isolated, the search must still go on for the ultimate virus particles.

THE MUSEUMS ASSOCIATION

ANNUAL CONFERENCE AT YORK

THE fifty-ninth annual conference of the Museums Association was held at York during June 22–26 under the presidency of Dr. F. J. North, of the National Museum of Wales. It was on May 3, 1888, that museum curators from all parts of Britain were called by the Yorkshire Philosophical Society to discuss matters of common interest; and a further meeting, also at York, on June 20, 1899, witnessed the formation of the Museums Association.

The Conference was attended by about 330 delegates of whom eleven were from overseas. Except for the presidential address and the papers describing the policy and collections in the four museums in York, the theme centred about "Museums and the Public". The main subject for discussion was the methods of display or presentation for the various kinds of museum and art gallery material. The Conference early admitted that there have been radical changes in recent years, and lively discussion ensued as to whether the so-called 'shop-window technique' had not been over-stressed. Quite wide differences of opinion were also expressed regarding what should be shown in the exhibition cases. It was evident that scientific advances and new materials offer new solutions to the practical problems of exhibition, but that these are not without their dangers if attempted by those without adequate training.

Dr. North, in his presidential address, endeavoured to answer the questions: "Why Museums and Wherefore the Museums Association?". He felt that the irreplaceable contribution of museums is in their power to enable us to recapture the capacity to wonder. He also maintained that our understanding and enjoyment of common things can be greatly enhanced by what museums have to tell us about them. Museums can inspire a lively curiosity about the works of Nature and man, and provide a potential antidote to boredom, one of the greatest evils of modern life. Although by its articles of association the Association is precluded from trade union activities, it can advance the interest of its members and help them to render even better service to the community. The *Journal* and the annual conference provide for the interchange of views and the pooling of experience, while the diploma and training schemes seek to establish a recognized professional status.

Among the specialized papers, Dr. Mary Woodall (Birmingham) dealt with the display of paintings, and Mr. Ian Finlay (Edinburgh) with the display of other art objects. The former paper produced a lively discussion concerning the advisability or otherwise of glazing paintings. Although this is a difficult problem in which many factors must be considered, the balance of opinion veered to the elimination of glass protection. Dr. Woodall also advocated the use of small intimate rooms as well as the lofty and pompous galleries, and preferred textiles for background rather than distempered or painted walls.

Mr. H. Stansfield (Liverpool) described the difficulties of an effective display for botanical material and emphasized the importance of showing living specimens. He also stressed that there is more value in discovering new facts about common plants than in merely pointing out a rare one. He stated that illuminated dioramas can be used to link plants of the past with those of the present day, and advocated the presentation of the economic aspects of botany.

Mr. A. J. Butler (Geological Museum, London) said that it is possible to present geology to the public in a manner which gives pleasure to the emotions and the intellect; it is not a fusty academic discipline. Dioramas showing present scenery and reconstructions of the past, coloured relief models and photographic exposition have already proved their worth. Mr. Butler visualized an extended use of coloured photographic prints and colour films of scenery, and of the international exchange of special photographic exhibits dealing with areas famous for their geology.

Mr. A. Hazelwood (Bolton) suggested an introductory exhibit in zoology illustrating the terms used in classification. He advocated modified habitat groups in which the display is produced with the minimum of scenic distraction and the use of plastic-embedded specimens displayed together with enlarged models.

Dr. Iorworth C. Peate (Welsh Folk Museums, St. Fagans) maintained that a folk museum should represent the natural setting and environment of the life portrayed through the exhibits. It should have a museum building for the systematic display of material and act as a centre for archives and research. It should also contain a lecture theatre for activities illustrating national or regional life. Around the folk museum should be displayed old buildings which have been carefully removed from their original sites and furnished as complete exhibits portraying the normal life of the particular period.

At the annual general meeting, the Association established the 'technical certificate' which will be awarded only to those who attain the required degree of proficiency and will provide official recognition for those who work in museum laboratories and workshops. It will be complementary to the diploma of the Association, which was established twenty years ago as the professional qualification for the administrative and curatorial staff.

At the same meeting the Museums Association Benevolent Fund was launched, the purpose of which is to help members and their dependants in financial difficulties in a profession that with few exceptions is inadequately paid.

Sir Leigh Ashton (Victoria and Albert Museum, London) was elected president for 1953–54, and the next annual conference will be held in Edinburgh during July 19–23, 1954.

INTERNATIONAL RADIO CONSULTATIVE COMMITTEE

FORTHCOMING PLENARY ASSEMBLY IN LONDON

THE seventh plenary assembly of the International Radio Consultative Committee (C.C.I.R.) will be held in London during September 3–October 7, inclusive. This assembly will discuss various technical problems encountered in the practice and development of radio communication, with the view of making recommendations to be submitted to the International Telecommunications Union (I.T.U.). The previous plenary assembly was held in Geneva in 1951; but three of the study groups of the Committee met in Stockholm in 1952 in order to give technical advice and assistance in the assignment of very high frequencies for broadcasting and television services in Europe (see *Nature*, **170**, 185; 1952).

The work of the Committee is organized under fourteen study groups, the chairmen and fields of activity of which are as follows: (I) Dr. Ernst Metzler (Switzerland), transmitters; (II) M. Pierre David (France), receivers; (III) Dr. H. C. A. van Duuren (Netherlands), complete radio systems used by the different services; (IV) Prof. L. Sacco (Italy), ground-wave propagation; (V) Dr. R. L. Smith-Rose

(United Kingdom), tropospheric wave propagation; (VI) Dr. J. H. Dellinger (United States), ionospheric propagation; (VII) M. B. Decaux (France), radio time signals and standard frequencies; (VIII) Mr. A. H. Cannon (Australia), international monitoring; (IX) Mr. H. Stanesby (United Kingdom), general technical questions; (X) Mr. N. McNaughten (United States), broadcasting, including questions relating to single sideband; (XI) Mr. E. Esping (Sweden), television, including questions relating to single sideband; (XII) Mr. B. V. Baliga (India), tropical broadcasting; (XIII) Mr. J. D. H. van der Toorn (Netherlands), operation questions depending principally on technical considerations; (XIV) Prof. T. Gorio (Italy), vocabulary.

Many of the subjects under consideration by these study groups are of considerable scientific interest, particularly in the fields of standards and measurements, wave propagation, atmospheric noise, television, and the application of information theory to the improvement in the efficient and economical use of the radio-frequency spectrum. Adequate liaison arrangements have been established between the International Radio Consultative Committee and the International Scientific Radio Union (U.R.S.I.) for the discussion and exploration of subjects of mutual interest. The United Kingdom delegation to the Committee is formed under the auspices of the General Post Office, which is the administration responsible for telecommunications in Britain.

RADIO-ASTRONOMY IN THE TROPICS

By Prof. H. E. HUNTLEY
University College, Achimota

In January 1952, the Physics Department of the University College of the Gold Coast brought into operation a radio-astronomy observatory at Achimota, about seven miles from Accra. Its situation gives the station certain advantages. Unlike stations in higher latitudes, its proximity to the equator makes it possible to survey both the northern and southern celestial hemispheres and to observe the sun at zenith angles which are relatively small throughout the year.

The station's equipment includes a twin aerial array forming an interferometer, each array consisting of eight horizontal full-wave dipoles with ground screen, the spacing between the arrays being 30λ ($\lambda = 6{\cdot}7$ m.). Preamplifiers are provided at each aerial array to neutralize attenuation losses in the cables and increase the signal/noise ratio. The line joining the arrays being in the east–west direction, the collimation plane contains the meridian. The interference pattern is such that the angular separation of the maxima or minima of central lobes is about 2° in Right Ascension.

The receiver and amplifiers incorporate the phase-changing switch described by Ryle[1]. This delicately adjusted unit was constructed by skilled African mechanics in the science workshops of the University College under the supervision of Fr. J. R. Koster, a lecturer in the Physics Department. The output of the receiver is recorded by an Evershed and Vignoles duplex recorder which employs a siphon pen writing on a clock-driven paper strip, the speed of which can be varied within wide limits.

The construction and maintenance of a radio-astronomy observatory in the tropics occasion certain difficulties which are not encountered in temperate climes. All wood associated with the aerials must be impregnated with creosote against the ubiquitous white ant. Tropical undergrowth which would speedily obliterate the ground screens requires frequent attention. To meet the danger of flooding as a result of tropical rain storms, the hut which houses the receiving equipment is built on piles. Thunderstorms are of such frequency and violence at certain seasons that the register shows little more than a continuous record of lightning flashes. The tropicalization of electronic apparatus is obligatory. Even so, there has been a disappointing series of failures of components, particularly transformers, followed by an unavoidable delay in repairs since replacements must be obtained from overseas.

In certain respects, however, this tropical station has advantages. Such excellent wood as African mahogany is immediately available and cheap. Unskilled labour is plentiful and inexpensive. The African 'lord of the manor' demands only a token rent for the land occupied by the station. There is, moreover, a latitude of choice of pitch which makes the avoidance of man-made electrical interference relatively simple.

The current programme of work in the observatory includes the hour-by-hour recording of ionospheric (*F*-layer) disturbances of radiation received from radio stars. It has already become clear that at certain seasons the incidence of these disturbances is more frequent in tropical than in temperate latitudes. It was a cause of some surprise that they are often of such violence as to obliterate almost entirely the radiation of so conspicuous a radio star as that in Virgo. The sun's activity at noon is of course included in the daily record, so that sunspots and such solar flares as are active at midday are under observation. Less frequent events, such as the occultation by the sun of the radio star in Taurus (June 1953), are observed and should yield useful information. Since the situation of the observatory affords a favourable view of radio stars of low declination, it is hoped to initiate a programme for determining the co-ordinates of their positions.

The staff of the observatory owes much to the interest in it shown by Mr. M. Ryle, of the Cavendish Laboratory, Cambridge, who, recognizing the advantages of a site near the equator, has given valuable advice and encouragement.

[1] Ryle, M., *Proc. Roy. Soc.*, A, **211**, 351 (1952).

INITIAL SPREAD OF MYXOMATOSIS IN AUSTRALIA

By JOHN LE GAY BRERETON*

In spite of the fact that the time and position of the introduction of myxomatosis to wild rabbit populations in Australia are known, the course of the spread of this disease which gave rise to the first epizootics of 1950–51 was unknown. This happened because epizootic centres sprang up suddenly in unsuspected and far-distant places. This led to the supposition that the disease was spread by wind-blown mosquitoes[1–3]. This article advances another

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Table 1. Rate of Movement of Myxomatosis

Position	Time (days)	Miles	Rate (miles/day)	Incidence
Macquarie River				
'The Mole', 64 miles downstream from Warren	—	—	—	*H*
Gin Gin, 10 miles north-east Trangie	36	86	2·4	*H*
'Nautilla', 11 miles east Dubbo on the Talbragar	28	65	2·3	*L*
	64	151	2·4	
Warrego River				
Fords Bridge, 40 miles north-west Bourke	—	—	—	*H*
'Cato Station', 5 miles east Enngonia	12	40	3·1	*L*
'Bowra', at Cunnamulla	24	90	3·7	*L*
'Rosevale', Wyandra	29	63	2·2	*H*
'Collaroy', 5 miles north Charleville	25	65	2·6	*L*
	90	258	2·9	
Paroo River				
Wanaaring	—	—	—	*L*
Hungarford	13	50	3·8	*L*
'Calwarro'	16	35	2·2	*L*
'Springvale', Eulo.	16	40	2·5	*L*
	45	125	2·8	
Bulloo River				
'Tickalara', near Bulloo Lake	—	—	—	*H*
'Ardock', 35 miles north Thargomindah	50	135	2·7	*L*
	50	135	2·7	
Maranoa River				
'Rookwood', 100 miles south Mitchell	—	—	—	*H*
'Kamerooka', 40 miles south Mitchell	21	60	2·9	*H*
	21	60	2·9	

H refers to high incidence, denoting a perceptible change in the population; *L* refers to low incidence, denoting imperceptible change.

hypothesis, with supporting evidence. It is considered to be more acceptable and simpler.

During a survey of the distribution and incidence of the disease in some of the northern rivers of the Murray–Darling system, it was possible to get reports on the time at which the disease was first seen. In this way it was possible to trace the continuous movement of the disease along five rivers and to calculate the rate of movement. From this information it has been possible to reconstruct a likely course of events leading to the distribution at the time of the first epizootics.

Two hundred and twenty station-owners, managers, station-hands and other interested people were interviewed and nineteen were found to have precise information about the date on which they saw the first sick rabbit. Great care was taken to ensure that the correct date was obtained. Some people had diary entries, others could relate the event to other events of well-known date like Christmas Day, sheep sales, etc. It was much easier to determine that the disease was continuous along the rivers, for while many were not sure of the date of arrival, all were sure of whether they had seen sick rabbits or not, and whether the incidence had been high or low. It should be noted that all country people were intensely interested in the disease after December 1950 when it was known to be spreading; and where it was not yet present, people were looking for it. Thus it may be assumed that the first finding of sick rabbits roughly corresponds with the first occurrence of the disease.

The results are set out in Table 1. It will be seen that the movement was at about three miles a day. It is of interest to note that there appears to be no increase in rate when the disease is in high incidence.

From this evidence it is reasonable to assume that the disease always "creeps" and that "passive carriage on high level winds"[2] and "jumps"[1,2] do not occur. This hypothesis may be tested by seeing at what rate the disease would have to move along the Murray and Darling from the first introduction site (see map) in order to have the distribution which was displayed by the epizootics of the summer of 1950–51. In Table 2 is set out the straight-line river distance from the site of the first introduction near Echuca in late May 1950 to the known positions on the northern rivers, and it is clear that the rate is approximately the same as that found on the five rivers studied. This test, therefore, supports the hypothesis. Further, the disease was found to exist at Claraville north of Alice Springs in August 1951[3]. The distance along the waterways from the Bulloo Marshes is about seven hundred miles and the time elapsing is about 187 days, which is again about three miles a day (Table 2 and map). The disease is known to exist at a number of intermediate points[3]. It is noteworthy that this movement occurred during the winter months.

An interesting corollary of this hypothesis is that the disease must have been spreading throughout the winter months of 1950. This is surprising because

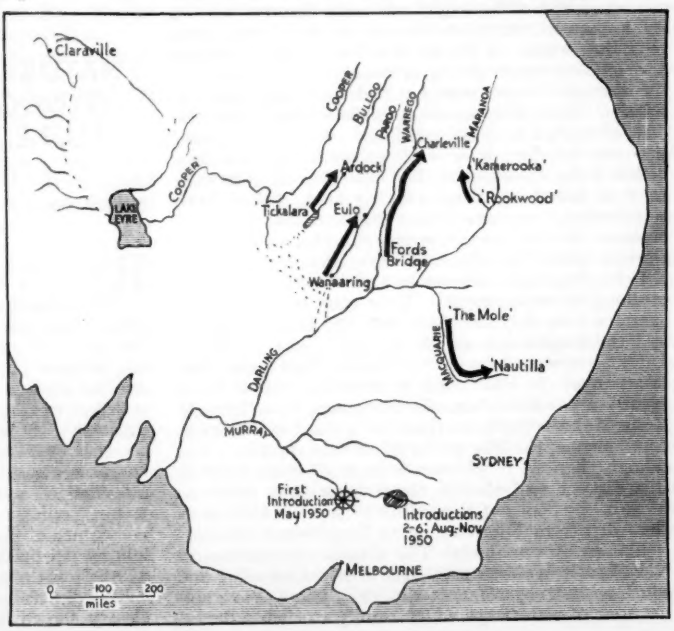


Table 2. Winter Movement of Myxomatosis

From	To	Time (days)	Miles	Rate
Euchuca Late May 1950	'The Mole' Dec. 26, 1950	240	740	3·1
"	Wanaaring Jan. 16, 1951	261	605	2·3
"	Fords Bridge Dec. 25, 1950	239	660	2·8
"	Bulloo Marshes Feb. 2, 1951	278	765	2·7
"	'Rookwood' Mar. 3, 1951	307	915	3·0
Bulloo Marshes Feb. 15, 1951	Claraville Aug. 1951	187	700	3·7

insect vectors are thought to be few in winter. Nevertheless, this performance was repeated in the winter of 1951, as has just been shown. Moreover, it persisted throughout its known range, and spread to new localities within this range during the winters of 1951 and 1952 [3]. There is no doubt that the disease can spread in winter.

The capacity of the disease to move at low incidence is well shown in Table 2, for much of the movement in the late summer and autumn of 1951 occurred at low incidence. It is worth while to mention here that this movement, independent of season or disease incidence, suggests that the rabbit and not some insect vector is responsible for the movement, while insect vectors have perhaps a greater role in determining incidence. The epizootics always appeared to coincide with abundant insect life, and this in turn coincided with severe flooding and summer temperatures, while the movement of the disease appears to be independent of temperature and humidity.

This movement at low incidence may partially account for the complete absence of reports of sick rabbits during the assumed spread in the winter of 1950. It must be remembered also that the country is very sparsely settled, the graziers in these parts are not concerned about rabbits, such rabbit industry as may exist is not going to advertise diseased rabbits for human consumption should any be found, and, most important of all, no one but a few scientists and officials knew of the presence of the disease in the country. People were not looking for sick rabbits. Further than this, even specialists may miss the disease when it is in low incidence. One experimental site was left by those working on it because they believed the disease had died out; but some months later it flared up here, proving that it had been continuously present. These circumstances may well account for the spread along the Murray and the Darling during the winter of 1950 not being observed.

It has been pointed out how closely this disease is confined to waterways[3]. It is thus of interest to examine how it could shift from the Darling system into the Cooper system. In the first place, we do not know accurately how far the disease does creep from waterways. It was found in scattered places up to twenty miles away from the Macquarie near Trangie. None of these was more than five miles from another. At this time, the Macquarie River was running; but though there is much ramification of waterways in this district and though these waterways had been filled in the floods of November–December 1950, they were dry from February on to June when this particular study was made. The situation in north-west New South Wales, north-east South Australia, and south-west Queensland is similar. There is a great network of waterways which ramify to such a degree that for practical purposes no watershed exists. They are normally dry; but the flooding of December 1950 was exceptionally great. For these reasons then it is not surprising that the disease was able to "creep" into this river system. However, it is noteworthy that it did not appear in the coastal river systems, which are separated by greater distances.

Ratcliffe *et al.*[3] have suggested that because gaps of up to fifty miles exist in the disease on the South Australian coast this is evidence of "jumps". However, it is clear that a patchy distribution is no proof of discontinuity. It is likely that a close study would reveal a band of disease along the coast from both sides of the Murray mouth. It must be remembered that a disease may be like a bush fire, with active burning at the fronts, and smouldering patches in the rear. We would not conclude from the discontinuous smouldering patches that the fire was moving by jumps. The most satisfactory evidence from which to conclude that "jumps" occurred would be the presence of the disease on both sides of a substantial barrier such as a desert or a sea; but no such evidence exists.

Pending sound evidence to the contrary, we may assume that myxomatosis spread by "creeping" along the rivers at about three miles per day from its initial introduction site near Echuca in May 1950.

My thanks are first owed to the various people of inland Australia whose observations and theories are the basis of this paper. Special thanks are due to Messrs. F. Jessup, M. Grey and B. Cameron, of the C.S.I.R.O., Mr. Mac Anderson, of the Pastoral Protection Board at Nyngan, and Mr. David Lee, of the School of Public Health and Tropical Medicine, Sydney.

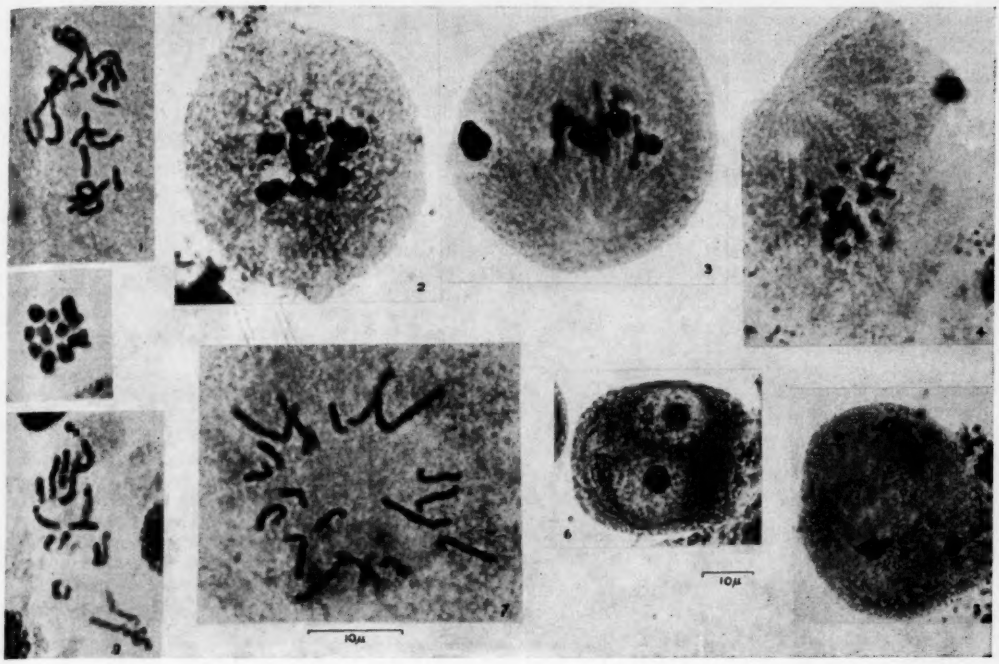
[1] Ratcliffe, F. N., and Fennessy, B. V., *Aust. J. Sci.*, **13**, 103 (1951).
[2] "The Rabbit Problem, A Survey of Research Needs and Possibilities". Supplement: "Mosquito-borne Myxomatosis" (C.S.I.R.O., Melbourne, 1951).
[3] Ratcliffe, F. N., Myers, K., Fennessy, B. V., and Calaby, J. H., *Nature*, **170**, 7 (1952).

MATURATION AND PROBABLE GYNOGENESIS IN THE LIVER FLUKE, *FASCIOLA HEPATICA* L.

By Dr. ANN R. SANDERSON
Natural History Department, University of St. Andrews, University College, Dundee

RECENTLY when we happened to have a stock of living *Fasciola hepatica* in the laboratory, I made a few aceto-orcein squashes of the reproductive organs and was much impressed by the suitability of the material for demonstration work in cytology, for the following reasons: (1) from a single individual one can obtain an abundance of material for demonstration of maturation of both male and female gametes; (2) the chromosomes are large and can be counted even under a 2/3 objective; (3) the uterus contains capsules with eggs at different stages of maturation, and these, when removed and placed in water, continue their development right up to the emergence of the miracidia in about five weeks under laboratory conditions; (4) the material is available at all times of the year.

The diploid number of chromosomes is twenty, as clearly shown in early cleavage (Fig. 7), and similar



counts are readily obtained from spermatogonia (Fig. 9). First spermatocytes occur in rosettes of eight, and, in these, chiasmata are distinct in orcein squashes but show up best in Navashin-gentian-violet smear preparations. Ten bivalents are shown in Fig. 8. The ovary is relatively small, and oogonial plates are rather difficult to find since they occur singly and not in rosettes (Fig. 1). The egg is ecto-lecithal, and in aceto-orcein squashes the capsule bursts, usually around the cap, and the egg and yolk cells flow out in a flat sheet. The ooplasm is yolk-free and the maturation spindle is large and extends across the whole egg. The spindle is formed independently of the entrance of the sperm (Fig. 2) and appears to persist for a lengthy period. On entering the egg, the sperm swells up and stains faintly at first. Later it rounds off as a spongy mass outside the spindle area (Fig. 3). Despite careful search I have not seen any evidence of the formation of a male pronucleus. In examination of more than two thousand eggs of an age likely to be in first maturation division, I have found only four in which the chromosomes pass to telophase (Fig. 5). My impressions are that the bivalents fall apart (Fig. 4) and that later each set segregates around a nucleolus. I have not yet completed the investigation; but it appears that two equal-sized vesicular nuclei appear within the egg (Fig. 6). Later, after liberation of the capsule from the uterus, these fuse and give rise to a cleavage nucleus with two nucleoli. The first cleavage spindle in the now enlarged egg has the diploid number of chromosomes and gives rise to two unequal cells, each with two nucleoli. One of these is probably the propagatory cell found by Rees[1] in *Parorchis acanthus*. No polar body has been observed and the sperm nucleus seems to disappear in most cases before the fusion of the two vesicular nuclei. If my interpretation of these phenomena be correct, the fusion of the two nuclei is a method of regulation of the chromosome number, and the sperm does no more than activate. Gynogenesis has been recorded by Lepori[2], Benazzi-Lentati[3] and Benazzi[4] in free-living Turbellaria; but to the best of my knowledge it has not previously been recorded in the parasitic Trematoda.

Henneguy[5] investigated *Fasciola hepatica* and found neither polar body nor second maturation division in the egg. The paper by Schellenberg[6] was published when the rival theories of telosynapsis and parasynapsis were being hotly contested and when Janssens's observations on chiasmata were first made known. His illustrations agree fairly closely with my preparations; but his interpretation is obviously erroneous. He believed the diploid number to be 12, although he figured both nine and ten bivalents. I also have preparations of eggs showing nine bivalents; but in well-spread plates ten can clearly be seen. He endeavoured to explain discrepancies in number by a theory of late disjunction in some of the chromosomes; but, in my opinion, his difficulties arose on account of the prevailing method of preparation—by sectioning. His figures of the second division and of the polar body are far from convincing.

Although my Feulgen preparations are very clear, they yield no advantage over aceto-orcein squashes. In order to investigate further the fate of the sperm, it will be necessary to make some iron–hæmatoxylin preparations; but I would point out that Schellenberg used this stain yet failed to find any centrosome derived from the sperm nucleus.

Apart from the interest attached to the probable occurrence of gynogenesis, I feel that *Fasciola hepatica* is worthy of greater attention by cytologists. If gynogenesis should be proved to exist in the liver fluke, then I would suggest that other hermaphrodite animals should be further investigated, as the

phenomenon may be more common than generally believed. [Jan. 10.

Note added to proof, June 5. Since this communication was submitted, an article on spermatogenesis in the liver fluke has been published by Mr. Bernard John[7], in which he states that the diploid chromosome number is twelve. If we are dealing with the same species, then the discrepancy must be due to the different methods of technique employed. Mr. John has used only sectioned material (Carnoy-iron hæmatoxylin). Cytologists to-day are generally agreed on the necessity for checking chromosome numbers by squash or smear methods. To obtain photographs where numbers are fairly high, the chromosomes must be well spread out to give a flat field. Over-much pressure on the coverslip may lead to broken chromosomes and an apparent higher number; but the number can be checked by careful drawing of more compact plates. In the fluke I have examined such plates stained by orcein, Delafield's hæmatoxylin and Feulgen in eggs in unbroken capsules. I have not used Carnoy as a fixative for *Fasciola*, but some years ago I sectioned material fixed in Navashin. I have re-examined this and feel obliged to state that for chromosome counts sectioned material compares unfavourably with squashed material.

[1] Rees, G., *Parasitol.*, **31** (4), 417 (1939).
[2] Lepori, N. G., *Caryologia*, **1** (2), 280 (1949).
[3] Benazzi-Lentati, G., *Caryologia*, **1** (3), 321 (1949).
[4] Benazzi, M., *Chromosoma*, **3** (6), 474 (1951).
[5] Henneguy, L.-F., *Arch. d'Anat. Micr.*, **9** (1906).
[6] Schellenberg, A., *Arch. Zellforsch.*, **6**, 445 (1911).
[7] *Quart. J. Micro. Sci.*, **94**, Pt. 1, 41 (1953).

'AFFINITY' IN MAIZE

DEVIATIONS from random segregation, analogous to those described in the mouse by Michie and Wallace[1], have been known for some time in maize. In view of the bearing such deviations from Mendel's second law, of independent segregation, may have upon the dynamics of chromosomes at meiosis, it appears useful to direct wider attention to what is known of the phenomenon in maize.

Affinity, which he termed 'false linkage', has been reported by Longley[2] to occur when there is preferential segregation at megasporogenesis of an abnormal type of chromosome 10[3]. This abnormal chromosome has a large, mainly heterochromatic, extra portion joined to the end of the long arm. In a plant heterozygous for abnormal 10 rather more than 70 per cent of the functional megaspores receive the abnormal chromosome, instead of the 50 per cent expected by chance. Rhoades[3] showed this was not due to competition between megaspores, of the kind found by Renner in *Oenothera*, but to a preferential segregation of the abnormal 10 to the chalazal megaspore. The degree of preferential segregation is affected by environmental factors.

Each of the ten chromosomes of maize may have one or more heterochromatic knobs which are visible during the pachytene stage of meiosis. The positions of particular knobs are characteristic, and their presence, or absence, is a character of the particular strain. Many strains have few knobs, or even none. The presence and absence of a particular knob on a chromosome, symbolized respectively as *K* and *k*, can be used, like two allelic genes, as genetic markers. Microscopic study of the progeny of a cross between a plant heterozygous for a particular knob and one which is knobless permits the detection of non-random segregation of the knob. Longley[2] found preferential segregation of the knob to the functional megaspore in knob heterozygotes, the preference being greatly accentuated if the plant was simultaneously heterozygous for the abnormal chromosome 10 (Table 1).

Table 1. Preferential Segregation of Knobbed Chromosomes at Megasporogenesis in Maize: Data of Longley[2]

Chromosome 10 constitution of parents	Chromosome 10 in megaspores	Knobbed chromosomes	Knobless chromosomes	Per cent knobbed	χ^2
Abnormal 10 / Normal 10	Abnormal	616	302	67·1	107·4
	Normal	420	244	63·3	46·7
Normal 10 / Normal 10	Normal	122	73	62·6	12·3

Preferential segregation was also observed in respect of some genes linked to knobs on chromosomes other than chromosome 10. Data are available for the *C*, *sh* and *wx* loci on chromosome 9 and for the *py* locus on chromosome 6. These data do not confirm the occurrence of preferential segregation in the absence of abnormal 10 which was suggested by the cytological data, but they do substantiate the occurrence of preferential segregation of knobbed chromosomes in the presence of abnormal 10. In the case of chromosome 9, the knob used was at the end of the short arm. All the test crosses had the dominant on the knobbed chromosome only, so the data contain no proper control by which the effects of viability differences on the estimate of preferential segregation can be readily eliminated. However, they do show (Table 2) effects large for the loci (*C* and *sh*) nearer to the knob and small for the locus (*wx*) farthest from the knob. The bias value is expected to be larger for the *C* locus than the *sh* locus; actually the observed value for the *C* locus is smaller, but not significantly so. The locus *wx* is close to the centromere of chromosome 9, and the order of value of the effects shows that the preference is occasioned by and from the knob. Any preferential segregation of the centromere and of genes in its neighbourhood is caused by the linkage of the centromere to the knob and not through the knob inducing a physiological change in the centromere, by which it exercises preferential orientation in the spindle. It is unknown

Table 2. Preferential Segregation in Maize of Chromosome 9 Genes in the Presence of Abnormal Chromosome 10; Data of Longley[2]

Gene	Per cent recombination with knob	Per cent of megaspores with dominant gene		
		In presence of abnormal 10	In absence of abnormal 10	Difference
C	23	63·87±0·23	49·48±0·243	14·39±0·345
Sh	26	65·71±0·995	50·08±1·47	15·63±1·78
Wx	44	53·43±0·316	51·01±0·398	2·42±0·508

Table 3. Affinity in Maize; Data of Longley[2]

F_1 genotype			Numbers of progeny				Recombinations	
			Py C	*Py c*	*py C*	*py c*	Number	Per cent
$\frac{Py\ K}{py\ k}$	$\frac{C\ K}{c\ k}$	$\frac{Ab.\ 10}{Nor.\ 10}$	1,119	461	488	218	949	41·51 ± 1·61
$\frac{Py\ K}{py\ k}$	$\frac{C\ K}{c\ k}$	$\frac{Nor.\ 10}{Nor.\ 10}$	731	775	773	749	1,548	50·99 ± 1·27

whether the effect occurs if abnormal 10 is homozygous.

The preferential segregation of the abnormal chromosome 10 does not influence the segregation of allelic genes if the chromosomes bearing them are knobless, nor does it influence segregation at microsporogenesis.

As a consequence of the preferential segregation described above, genes in different chromosomes, each heterozygous for knobs, segregating simultaneously in the same plant, show a similar, if not identical, phenomenon to the 'affinity' in segregation shown in the mouse. Data are given in Table 3 for coupling backcross progenies involving the pigmy (*py*) and coloured endosperm (*C*) loci.

In maize, the affinity depends upon heterozygosity for heterochromatic parts of the chromosome, the preferential, or polarized, segregation of which is activated, or accentuated, by the presence of a special chromosome, in this case the abnormal chromosome 10. The centromeres are not the active agents in maize, nor is there evidence for their being the agents in the mouse. Two possible mechanisms, not necessarily mutually exclusive, may underlie the promotion of affinity in maize by the abnormal chromosome 10. One may be an increase in the frequency of the non-homologous pairing which is shown by knobs at the pachytene stage of meiosis. The other is the formation of supernumerary centromeres, apparently in the neighbourhood of knobs, which occurs in the presence of the abnormal chromosome 10 at both divisions of meiosis[4].

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Department of Genetics,
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[1] Michie, D., and Wallace, M. E., *Nature*, **171**, 26 (1953).
[2] Longley, A. E., *Genetics*, **30**, 100 (1945).
[3] Rhoades, M. M., *Genetics*, **27**, 395 (1942).
[4] Rhoades, M. M., and Vilkomerson, H., *Proc. Nat. Acad. Sci.*, **28**, 433 (1942).

I am grateful to Prof. Catcheside for directing attention to the observations in maize, and for affording me this opportunity of emphasizing an important distinction which I made in my previous communication[1] to which he refers. Of the two concepts which were differentiated under the names 'polar affinity' and 'mutual affinity', the former does little more than add an interpretative gloss to the phenomenon of 'polarized segregation' which has been described under that name by, for example, Catcheside[2]. It is the latter concept which is new, and it is the latter concept only—as can, I believe, be shown from our data[1]—which has application to the anomalous segregations observed in mice.

Now in the data of Longley[3] cited by Prof. Catcheside, polarized segregation involving 'knobbed' chromosomes, particularly chromosome 10, clearly occurs. It also appears that there may be an attraction (which it may seem reasonable to compare with 'mutual affinity') between the neo-centromeres of this chromosome and the neo-centromeres of other chromosomes—at least this seems to be one possible explanation of the enhancement of the polarized segregation of 'knobs' on other chromosomes (and of the attendant quasi-linkages) when abnormal 10 segregates to the preferred pole. Whether or not the term 'affinity' should in such a case be stretched to refer to neo-centromeres is discussed by Mrs. Wallace in the following communication.

I hope to publish a full treatment of these matters elsewhere.

Donald Michie

Department of Zoology,
University College, London.

[1] *Nature*, **171**, 26 (1953).
[2] *Ann. Bot.*, **8**, 119 (1944).
[3] *Genetics*, **30**, 100 (1945).

The observations of Longley and Rhoades on the knobbed chromosomes of maize, to which Prof. Catcheside's letter has directed attention, were considered during the formation of my own views on the observations in mice for which Dr. Michie and I have used the term 'affinity'. There is a superficial resemblance between them in that they are both examples of non-random segregation, and both produce similar (although not identical) apparent linkages. That the same principle may, as Prof. Catcheside has implied, be found eventually to underlie them is possible, but certainly not yet proven. Indeed, a recent paper by Rhoades[1] gives a stronger indication of this probability than is mentioned by Prof. Catcheside, for Rhoades maintains that the centromeres *may*, in fact, be the active agents in maize (as theory proposes them to be in the mouse); he has shown that "the true centric region is involved in the formation of neo-centromeres", the latter occurring in the region of 'knobs'.

However, the resemblance is, at least at present, no more than superficial, for there are several important differences, both observational and theoretical, which make the use of identical terms undesirable.

Two observational differences are at once apparent from the published work. First, the anomaly in maize is confined to the sex in which the two poles of the dividing cell have a different biological destiny —it has been observed only in megasporogenesis, whereas the anomalous segregations have been observed in both males and females in the mouse. Secondly, the false linkages in maize depend on the presence of a particular chromosome (abnormal 10), which shows polar preference even in the absence of other abnormal chromosomes, whereas in the mouse no particular allele marking a point of attraction is known to be essential to the process or to have a polar preference. An important theoretical difference has already been mentioned: the maize phenomenon is thought to be controlled directly by the neo-centromeres and perhaps indirectly by the centromeres, whereas, in the absence of evidence for neo-centromeres in the mouse, the phenomenon here is thought to be controlled directly by the centromeres.

It would seem judicious, therefore, in order to avoid confusion, that separate terms be used for each phenomenon as a whole, namely, 'polarized segregation'—or, as Longley terms it, "preferential segregation"—and, on the other hand, 'affinity', until such time as their true relationship is fully understood. The term 'attraction' appears to be a sufficient description of the relation between neo-centromeres proposed as an explanation of Longley's data[2], as it is also for the relation between centromeres proposed in the mouse.

M. E. Wallace

Department of Genetics,
Cambridge.

[1] *Heterosis*, 66 (1952).
[2] *Genetics*, **30**, 100 (1945).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Electron Microscope Photographs of Polished Mineral Surfaces

Although the electron microscope has a wide range of applications in many branches of science, apparently it has not hitherto been used in ore microscopy for the study of opaque polished mineralogical surfaces. The instrument can be applied to great advantage, however, in revealing mineralogical structures and textures not visible with an optical microscope, and in throwing additional light on the complex problems of ore deposition and the nature of ore-forming fluids.

The photographs reproduced here, taken with an electromagnetic transmission type of electron microscope, are of thin-film replicas prepared on polished surfaces of minerals and afterwards removed by a dry stripping process. In most cases it was found preferable to prepare the film on an electrolytically etched surface of the specimen, and to shadow the replicas before examination in the microscope. The maximum resolution obtainable using thin-film replicas is only of the order of 400 A., but even so this is about eight times as good as that of the best optical microscope.

Fig. 1. *Ex-solution particles of gold in cobaltite.* Replica obtained using a 0·75 per cent solution of 'Formvar' in chloroform; surface of specimen etched with equal amounts of 50 per cent CrO_3 and concentrated hydrochloric acid; immersion time, one minute; replica not shadowed; magnification, 3,600 diameters.

The gold particles are shown up in black; the small white circular spots represent holes in the thin-film replica. Two gold specks to the immediate right of the large patch are 0·36 μ and 0·29 μ, or 0·00036 mm. and 0·00029 mm., in diameter respectively. A thin veinlet of gold extends outwards from each side of the large gold particle. This photograph probably provides the first confirmation of the long-held belief that ex-solution products can exist in mineral specimens down to extremely small sizes, beyond the resolving power of optical microscopes. With the aid of the electron microscope it might well be possible to prove the presence of such inclusions at molecular sizes.

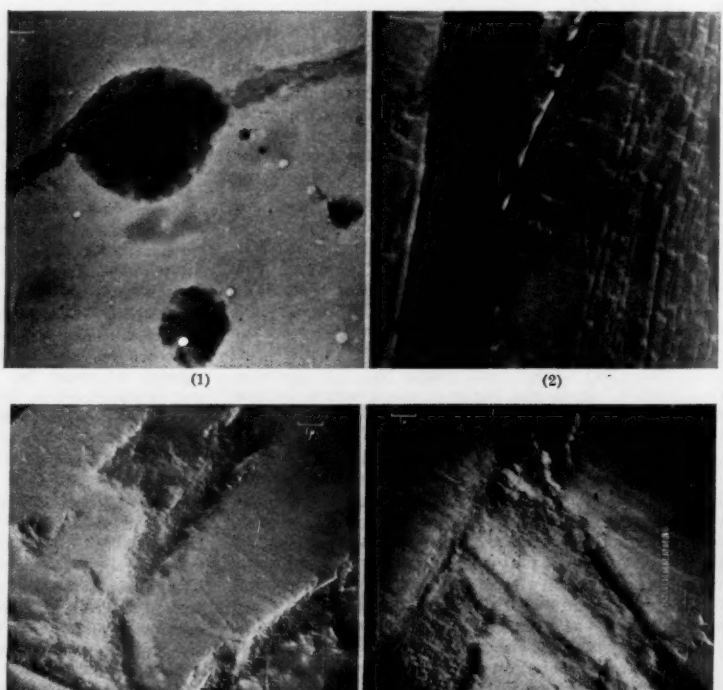
Fig. 2. *Ex-solution laths of cubanite in chalcopyrite.* Replica obtained using a 0·75 per cent solution of 'Formvar' in chloroform; mineral surface electrolytically etched with 50 per cent phosphoric acid; current 3 amp., voltage 2·5; immersion time, 10 min.; replica shadowed using gold–manganin alloy; angle of shadowing approximately 30°; magnification, 3,600 diameters.

The cubanite laths are represented as dark bands in the surrounding lighter background of chalcopyrite. An intriguing feature of the chalcopyrite is the peculiar structure along its margins, which cannot be resolved with an optical microscope. It may be a form of strain structure induced in the chalcopyrite during segregation of the cubanite laths.

Figs. 3 and 4. *Ex-solution lamellæ of ilmenite in magnetite.* Replica obtained using a 2 per cent solution of collodion; surface of specimen not etched; replica shadowed using gold–palladium alloy; angle of shadowing approximately 30°; magnification, 3,800 diameters.

In this case photographs with good contrast have been obtained from an unetched surface, despite the fact that ilmenite and magnetite are so similar in hardness. They illustrate that the ilmenite lamellæ, which under an optical microscope appear to have perfectly straight edges and smooth surfaces, actually have irregular margins and a fine surface structure. This surface structure on the ilmenite laths cannot yet be explained.

I wish to thank Dr. H. Wilman, of the Applied Physical Chemistry Laboratories at this College, for generously providing laboratory facilities, and in particular Mr. H. I. Matthews for his help and advice, without which this work would not have



(1) (2)

(3) (4)

been possible. Thanks are also due to Dr. G. L. J. Bailey and Mr. A. R. Heath, of the British Non-Ferrous Metals Research Association, London, for their co-operation and assistance.

J. KENYON

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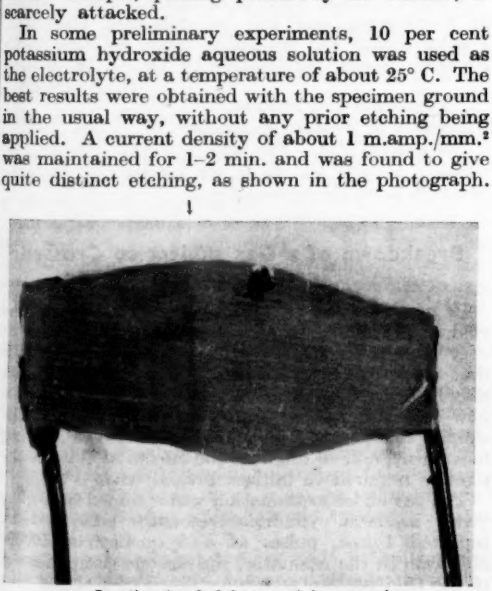
London, S.W.7. May 13.

p-n Junction revealed by Electrolytic Etching

IN the preparation and application of *p-n* junctions in germanium and similar materials, it is often important to locate the potential barrier precisely in order to attach electrodes or probes near by. Such a barrier is, in general, not visible, as the crystalline structure of the material on either side of it is identical, that is, a single crystal of germanium of high purity and with a high degree of perfection throughout. The fact that one part (the *n*-type region) conducts by electrons in the conduction band and the other (the *p*-type) in the valency band, that is, by 'holes', cannot be shown up by any of the standard metallographic techniques. The usual method of locating the barrier, namely, by electrical probing along the surface, is not very satisfactory.

However, the boundary can be shown up by using a method that depends on the rectifying behaviour of such a junction. The specimen is immersed in a suitable electrolyte, and electrical current is forced through it in such a way that only the *n*-region is anodically attacked, that is, the positive terminal of a battery is connected to the *n*-part of the specimen and the negative to an inert electrode, such as graphite, nickel, stainless steel, etc., serving as the cathode. Regarded as a rectifier, the junction is then biased in the blocking direction. The current flowing into the specimen cannot cross the barrier but passes into the electrolyte instead, and from there to the cathode. The *n*-type part of the specimen is therefore etched anodically, while the *p*-type part of the sample, passing practically no current, is scarcely attacked.

In some preliminary experiments, 10 per cent potassium hydroxide aqueous solution was used as the electrolyte, at a temperature of about 25° C. The best results were obtained with the specimen ground in the usual way, without any prior etching being applied. A current density of about 1 m.amp./mm.^{2} was maintained for 1–2 min. and was found to give quite distinct etching, as shown in the photograph.



p-n Junction (marked by arrow) in germanium

Various alternatives of the method can be used. Instead of using an independent (inert) cathode, the D.C. supply voltage may be applied directly across the two ends of the specimen, the anode to the *n*-part as before and the cathode to the *p*-part. Current passing into the *n*-part from the anode again cannot cross the junction barrier, but instead passes into the electrolyte and thence into the *p*-part of the specimen. There is practically no effect on that part of the germanium specimen acting as the cathode, while the *n*-part will be etched anodically as before. The leads connecting the specimen to the voltage supply should be insulated to avoid corrosion.

In a similar way, an *n-p-n* specimen can be made to show up the *p*-region; if connected with the two *n*-parts joined in parallel, these will be etched anodically, while the *p*-part will remain unaffected, practically no current passing through its surface; the cathode in this case should be a neutral material, for example, graphite.

It was noted that the electrolytic type of etching, while rendering the *p-n* boundary readily visible, is much less effective than certain chemical etches are in improving the rectifying characteristics of a junction. This is presumably because only a strong chemical etch will strip the junction completely of any contaminated surface layer which might otherwise act as a partial short-circuit in parallel with the high electrical resistance of the barrier. Electrolytic etching as described will only clear the *n*-part of the junction; if the *p*-part were used as cathode, electrolytic etching might make matters worse by cathodic deposition on the *p*-region close to the junction. The following rectification ratios were obtained on a particular junction after various treatments.

Treatment of junction	Surface ground	Electrolytic etch (*p*-part as cathode)	Electrolytic etch (independent cathode)	Chemical etch *C.P.*4
Rectification ratio	1:2	1:2·8	1:45	1:10,000

We wish to express our gratitude to E. W. R. Francis, who carried out most of the experimental work.

Since starting these experiments, it has come to our notice that similar techniques are being developed elsewhere in Britain and the United States.

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Travelling Disturbances in the Ionosphere

MEASUREMENTS of the horizontal velocity of travelling disturbances in the *F*2 region of the ionosphere have been made in this department over the past three years, using the method described by Munro[1]. Constant-frequency pulse transmitters were set up at the base station in the Physics Department of the University of Western Australia, and at two other stations situated respectively 15 miles east and 25 miles south-east. The two remote stations were triggered, after a short adjustable delay, by the

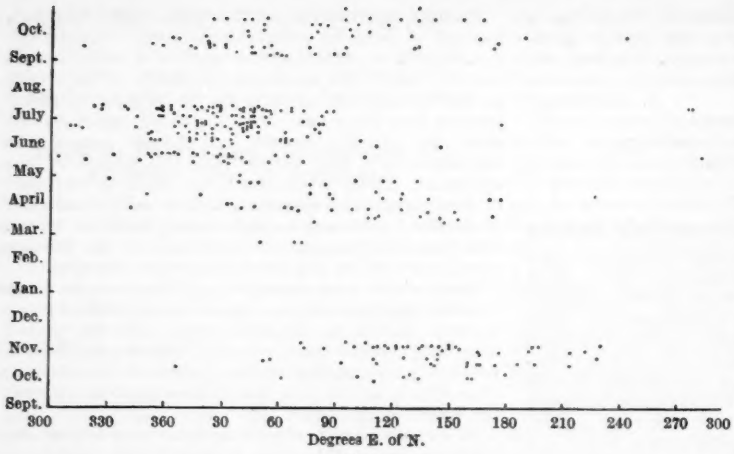

Fig. 1

ground wave from the University transmitter. Three sets of echoes were obtained at the base station, one reflected vertically from overhead and the other two at oblique incidence from the mid-points between the remote stations and the base. They were recorded on the one film by the conventional techniques. The frequency used was 5·8 Mc./s. and the pulses were 100 μsec. long with a pulse repetition frequency of 40 c.p.s.

It was found that changes in the reflecting layer occurred at different times at the three reflexion points, and the velocity of motion of these disturbances could be determined. These time differences occurred in nearly all disturbances of the reflecting layer, for example, peaks and dips of virtual height, splitting of ordinary and extraordinary rays; but discontinuities in the recorded trace, called "*Z*'s" by Munro, proved to be the most reliable.

The directions determined over the year are shown in Fig. 1. It was not possible to keep the system in continuous operation; but Munro's results show that, in Sydney, the directions are substantially constant during the non-recording periods in Perth.

The direction of travel in summer lies between 90° and 180° E. of N. and in winter between 0° and 60° E. of N. with a rapid change-over occurring in the equinoxial months (see Fig. 1). Variations between the two conditions occur; but the change from one set of conditions to the other is accomplished in a day. Fluctuations of up to 50° occur quite commonly during the day, and even larger ones have been noted. The speed has been found to vary from 5 to 20 km./min. with a maximum of occurrence at 10 km./min. (see Fig. 2); but no regular variation has been noticed.

The speeds (and also the number of *Z*'s per day) were compared with auroræ and the weather; but no correlation was obtained.

Another phenomenon that has been noted on the records is a quasi-periodic rise and fall of the virtual height. It is thought that this variation arises from the same meteorological source as the *Z*'s. The velocities determined agree quite well in direction with those determined from *Z*'s, but the speeds are generally much larger. These apparently greater speeds may be due to the method of analysis of the records.

The values of velocity obtained agree quite closely with those reported by Munro in Sydney, and it seems that the velocities are substantially constant for 2,000 miles[2].

A more detailed account of this work is in course of preparation and will be published elsewhere. I acknowledge the assistance given by the Radio Research Board, particularly by Dr. G. H. Munro.

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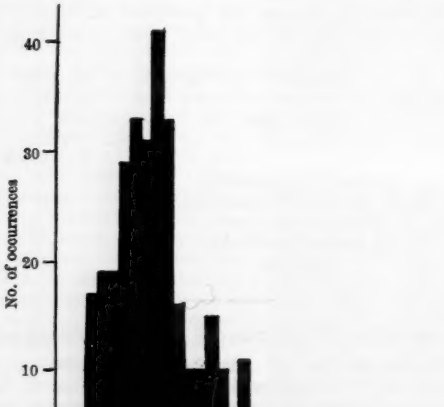
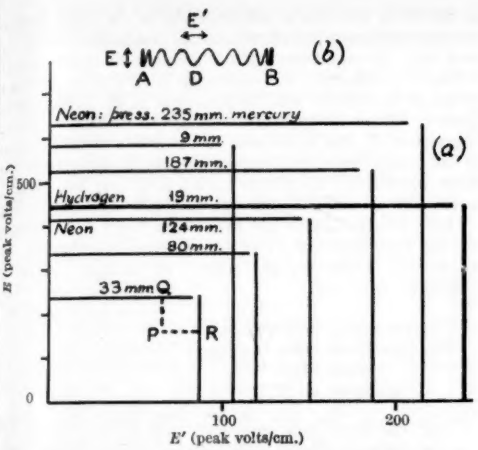


Fig. 2

Breakdown of a Gas subject to Crossed Electric Fields

In microwave breakdown of a gas, the amplitude of drift movement of an electron is small except at very low pressures, and the hypothesis has been made that the return of an electron over its previous track may help to initiate the discharge[1]. The experiments now reported deal with an attempt to convert the simple to-and-fro drift movement into a zig-zag movement, and to examine the effects of this on the stresses required to initiate breakdown.

The gas under examination was confined in a glass vessel inside a cylindrical resonator energized by repeated 1-μsec. pulses at a frequency of 10,000 Mc./sec. In the resonator, the electric component *E* of the field pattern set up consisted of a closed ring



(a) Typical conditions of breakdown in combined fields. Thick line, hydrogen; frequency of auxiliary field, 10 Mc./sec. Thin lines, neon; frequency of auxiliary field, 2·66 Mc./sec.

(b) Illustrating the movement of an electron in the combined fields: relative amplitude exaggerated in the E direction

of electric force in a plane perpendicular to the axis of the cylinder ($H011$ mode), the intensity falling off towards the resonator walls and towards the centre. In this mode, the wall currents are circumferential and so the ends of the resonator could be insulated from the cylindrical walls, making it possible to apply an auxiliary field E' in a direction generally parallel to the axis of the resonator. Steady fields so applied caused an increase in the microwave stress required to produce breakdown in air, hydrogen and neon, but the results are ambiguous in that the increase could alternatively be attributed to gross movement of the electrons and ions towards the walls of the containing vessel. Accordingly, alternating auxiliary fields were applied instead of unidirectional fields, at frequencies of 1, 3 and 10 Mc./sec., with results shown in Fig. *a* for a typical case.

Starting from conditions represented by a point such as P, on increasing the microwave field no breakdown occurred until the conditions at Q were obtained. Similarly, on increasing instead the 3-Mc./sec. field, no breakdown occurred until the conditions at R were obtained. It appears that the two fields act independently in producing breakdown, as shown by the rectangular form of the curves.

A partial explanation is as follows. The field of lower frequency is continuously applied and so the vertical lines may simply represent breakdown occurring in the intervals between the microwave pulses. If it be assumed that breakdown by the microwave field is facilitated by the return of the electron along its track, then breakdown will begin at A or B (Fig. *b*) and the results agree with the view that at D the breakdown stress is increased by the auxiliary field. This is supported by the observation that the statistical lag before breakdown increases with increasing values of E'. The surprising feature is the complete failure of the auxiliary field to help microwave breakdown, even when its value is only a little below that at which it could by itself initiate the discharge.

Grateful acknowledgments are made to the Department of Scientific and Industrial Research for a maintenance grant (P. E. L.), to the British Electrical and Allied Industries Research Association for a grant for apparatus and to the Director of that Association for permission to publish this communication.

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Variation of the Incompressibility of an Elastic Material subjected to Large Hydrostatic Pressure

Birch[1], using Murnaghan's finite elasticity theory, has shown that, at pressures existing in the earth's interior, the gradient of the incompressibility k, with respect to the pressure p, is a decreasing function of pressure. This communication reproduces the main features of Birch's results but, by starting from a later derivation of Murnaghan, it is found possible to obtain two useful formulæ for the calculation of k and dk/dp at large pressures.

In the course of his theory, Murnaghan[2] derives the formula:

$$\frac{d(\lambda + \frac{8}{3}\mu)}{dp} = \frac{\frac{8}{3}(\lambda + \frac{8}{3}\mu) - B + \frac{1}{3}p}{\lambda + \frac{8}{3}\mu + \frac{1}{3}p} \qquad (1)$$

where $k = \lambda + \frac{8}{3}\mu + \frac{1}{3}p$. B, a possible function of pressure, is a combination of second-order elastic parameters. It is impossible to obtain an exact solution of (1) without knowledge of the variation of B with pressure, but a solution can be obtained by assuming B to be an absolute constant. With this restriction, equation (1) can now be solved exactly, but the solution is unwieldy. In order to obtain a useful solution, we take $\lambda + \frac{8}{3}\mu$ in the second member of (1) equal to its value k_0 at zero pressure. Thus we obtain:

$$\frac{dk}{dp} = \frac{-k_0 - B + 4p/9}{k_0 + p/3}, \qquad (2)$$

which yields the solution:

$$k = k_0 + 4p/3 - (k_0 + 3B)\log(1 + p/3k_0). \qquad (3)$$

Towards solving equation (1) we have, in effect, taken the elastic parameters $\lambda + \frac{8}{3}\mu$ and B in the second member equal to their values at zero pressure. This implies that the approximate results (2) and (3) will not be valid for very large pressures, but no great discrepancy should be involved in the range of pressures occurring in the earth's interior.

The studies of the earth's interior have shown that the following values are at least correct to one significant figure:

$k_0 = 2 \times 10^{12}$ dynes/sq. cm.;
$k = k_0 + 4p$, where p is not too large;
$p_c = 2k_0$, where p_c is the pressure at the centre of the earth.

Using the result $dk/dp = 4$ where $p = 0$, we find from equation (2) that $B = -3k_0$, so that equations (2) and (3) become:

$$\frac{dk}{dp} = \frac{4k_0 + 4p/9}{k_0 + p/3}, \quad (4)$$

$$k = k_0 + 4p/3 + 8k_0 \log (1 + p/3k_0). \quad (5)$$

With equations (4) and (5) and the assumed values for the earth's interior, we can now construct the accompanying table, where the units of p and k are 10^{12} dynes/cm.

p	dk/dp	k	Depth
0	4	2	0
1	3·62	5·8	2,200 km.
2	3·33	9·3	3,500 km.
3	3·11	12·5	4,800 km.
4	2·93	15·5	centre

In the construction of this table, the assumption of Bullen's compressibility pressure hypothesis is implicit, and his values giving the variation of pressure with depth have been used to estimate the approximate depth. It will be noticed that there is a very good correspondence between the values of k obtained from equation (5) and Bullen's[3] values.

I wish to thank Prof. K. E. Bullen, of the University of Sydney, and Prof. G. Bosson, of the N.S.W. University of Technology, for their interest and assistance.

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An Extended Smith–Lagrange Invariant

It is well known in optics that, if μ_r is the refractive index of the rth medium of a co-axial system, h_r is the height of the image of a given object from the axis in the same medium, and α_r is the angle a selected ray makes with the axis at the image plane, then

$$\mu_r h_r \begin{Bmatrix} \sin \alpha_r \\ \tan \alpha_r \end{Bmatrix} \quad (1)$$

is invariant (Smith–Lagrange invariant). The choice of $\sin \alpha_r$ or $\tan \alpha_r$ varies with different authors. The relation holds in all systems where $\sin \alpha$ and $\tan \alpha$ are indistinguishable.

The development of various two-stage processes of image formation[1], in which the wave-length may be altered between object and image, makes it profitable to consider whether the wave-length can be introduced. Since wave-length is inversely proportional to refractive index, the form :

$$\frac{\mu_r h_r \sin \alpha}{\lambda_r} \quad (2)$$

as invariant suggests itself. It is readily verified in the case of diffraction microscopy that this is correct.

Hopkins[2] has recently published a coherence criterion for a beam of circular cross-section :

$$\frac{\mu h \sin \alpha}{\lambda} = \frac{z}{2\pi} \not> 0{\cdot}16, \quad (3)$$

in which h and $\sin \alpha$ are capable of two alternative interpretations, one of which agrees with that of (1) and (2). Comparison with (2) shows at once that, if a beam is coherent in one image plane of a Gaussian co-axial system, it will be coherent in all other image planes. Thus coherence is conserved in such systems. Moreover, if the invariant (2) exceeds 0·16 in numerical magnitude, the degree of partial coherence has been shown by Hopkins to be $2J_1(z)/z$, and is still invariant down the system, though now imperfect.

The Smith–Lagrange invariant thus corresponds to the physical law that the degree of coherence is conserved from image plane to image plane in Gaussian systems.

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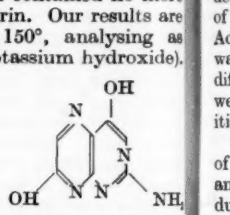
*Iso*xanthopterin

We have recently prepared *iso*xanthopterin (2-amino-4 : 7-dihydroxypteridine) by a new synthesis, namely, the condensation of triamino-4-hydroxypyrimidine with ethyl glyoxylate hemiacetal. The synthesis, purification and analysis will be reported in detail elsewhere. The ultra-violet spectrum of the product consisted of three peaks at the $\lambda_{max.}$ values previously reported[1,2], but the extinction coefficients were so much higher as to suggest that the samples previously examined contained no more than 80 per cent of *iso*xanthopterin. Our results are as follows (material dried at 150°, analysing as anhydrous, dissolved in 0·1 *N* potassium hydroxide).

$\lambda_{max.}$ (mμ)	ε	log ε
339	14,200	4·15
254	11,550	4·06
223	(38,000)	(4·58)



The ε at 223 mμ may be subject to a small error from stray light.

We wish to thank Dr. E. R. Holiday, of the Medical Research Council Spectrographic Research Unit, London Hospital, and Dr. F. Korte, of the Biochemische Abteilung, Chemisches Staatsinstitut of the University of Hamburg, for confirming the above spectrographic results, using our synthetic material. Dr. Korte tells us that previous spectra have been obtained only from material of natural origin.

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Effect of Ultra-violet Light on Deoxyribonucleic Acid in Rat Thymocytes

THE amount of deoxyribonucleic acid recovered from ultra-violet light irradiated intact rat thymocytes has been found to be significantly less than the amount recovered from non-irradiated controls. The thymus glands of twenty normal 150-gm. Wistar-strain male rats were removed immediately after decapitation of the animals, placed in 140 ml. of Ringer's solution and homogenized for 30 sec. in a Waring blendor. The resultant suspension of thymocytes was removed to a dark-room and divided into two equal portions, one of which served as a control. The other was placed in an 80-ml. quartz-bottom van Tieghem cell. While being constantly agitated by a slowly rotating stirrer, in order to ensure uniform exposure of all the cells, the suspension was irradiated from below for 30 min. with ultra-violet light ($3{\cdot}4 \times 10^3$ ergs). The ultra-violet source, used without filters, was an air-cooled, quartz-spiral mercury resonance lamp (Hanovia), which, according to a Hanovia ultra-violet meter, Model *AV* 971, emits about 25 per cent of the total output in the ultra-violet below $\lambda = 2800$ A. The irradiated and control suspensions were left in the dark-room to avoid possible side effects due to photo-reactivation. A period of 5½ hr. was allowed to elapse before extraction of deoxyribonucleic acid, in order to provide sufficient time for possible depolymerization of the acid induced by the radiation. Thymocyte viability for a period of 5½ hr. after homogenization and irradiation was verified by means of tissue culture. Deoxyribonucleic acid was extracted according to the Limperos modification[1] of the Mirsky–Pollister method[2], dissolved in distilled water and then lyophilized. The weight of deoxyribonucleic acid obtained from irradiated tissue homogenates (seven replicate experiments) was only 52·9 per cent ($S.E._{mean}$ 4·6) of the weight of that obtained from the non-irradiated controls. Nitrogen and phosphorus content were determined on aliquot portions made up on the basis of percentage weight of deoxyribonucleic acid. Adjustment to equal concentrations of the acid was based on phosphorus content. No appreciable differences between irradiated and control samples were found in relative viscosities, structural viscosities, or sedimentation rates.

Thymine was determined according to the method of Day[3] on the supernatant fluids (Ringer's solution and the 0·14 *M* saline extraction fluids) collected during the initial stages of the extraction process. The greater proportion of loss of deoxyribonucleic acid calculated on the basis of thymine content of the supernatant fluids from the irradiated tissue homogenates occurred during the 5½ hr. period following irradiation before the extraction of deoxyribonucleic acid.

Depolymerization of deoxyribonucleic acid *in vitro* by prolonged exposure to ultra-violet radiation was demonstrated by Hollaender *et al.*[4]. A fall in nuclear absorption of mouse lymphocytes, thymocytes and stem cells of bone marrow during such irradiation was reported by Bradfield[5] and was suggested by him to be due to depolymerization of the acid with immediate extranuclear leakage of the acid breakdown products.

The small amount of deoxyribonucleic acid recovered from irradiated tissue homogenates and the large amount of thymine present in the Ringer's supernatant fluids indicate that, as a result of ultra-violet irradiation, partial fragmentation of the polymerized deoxyribonucleic acid molecule occurred. Since no appreciable differences were found between the physico-chemical characteristics of the deoxyribonucleic acid recovered from the controls and from the irradiated homogenates, apparently not all the deoxyribonucleic acid in the irradiated homogenates was depolymerized. There was a slight loss of the deoxyribonucleic acid from the controls attributable to mechanical injury. The major loss of the acid from the irradiated homogenates, however, must have been due to ultra-violet radiation.

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Deoxyribonucleic Acid Content of the Cell Nucleus and Mitosis

THE fact that the deoxyribonucleic acid content in the nuclei of a given tissue remains constant at least between certain limits suggests that mitosis must necessarily be preceded, accompanied or followed by a synthesis of deoxyribonucleic acid. The moment of this synthesis is still under discussion.

The blastula of *Artemia salina* L. was chosen as material for the study of the problem. At the moment of the invasion of the blastocœl by the yolk granules[1] the nuclei remain near the surface of the germ and present semi-synchronous divisions, so that blastulæ practically devoid of mitosis and others with numerous nuclear divisions are easily found. After telophase, most of the newly formed nuclei can be recognized by their volume. The two little nuclei swell progressively during early interphase to the volume of the interphase nuclei.

It seemed to us that a comparison between the amount of deoxyribonucleic acid in nuclei of blastulæ devoid of mitoses and those with numerous mitoses could give some information upon the deoxyribonucleic acid content during nuclear division. The histochemical method of L. Lison[2] was used for this purpose. The calculated mean optical density of the nucleus multiplied by its surface gives the amount of deoxyribonucleic acid expressed in arbitrary units. The reported figures have only relative values. Those brought together in each of the histograms (*A*, *B*) correspond with nuclei found in sections of a female fixed *in toto* (alcohol 9, formalin 1), which were brought on to the same slide to ensure a uniform Feulgen reaction. In the histograms the relative amounts of deoxyribonucleic acid are plotted logarithmically as abscissæ and the relative frequencies of the classes comprised between two successive figures of the horizontal scale are plotted as ordinates. As reference, the spermatozoids

abundantly present in the general cavity of the females were measured.

In histogram *A* the mean deoxyribonucleic acid content of the (haploid) spermatozoids obtained by 110 measurements corresponds to 96 arbitrary units. The contents of nuclei contained in six blastulæ devoid of mitoses vary between wide limits. Those variations are in no way connected with those of the nuclear dimensions and forms. The existence of a definite frequency maximum enables us to calculate a mean value from the 215 measurements. This value (176 arbitrary units) was found, as expected for those diploid nuclei, to be nearly twice the content of the spermatozoids.

Histogram *B* summarizes the results obtained from five blastulæ which contain numerous mitoses. The mean deoxyribonucleic acid content of the spermatozoids found in the sections on the same slide, as calculated from fifty measurements, corresponds to 99 arbitrary units. Nearly 160 interphase nuclei were measured. The histogram shows clearly two frequency maxima. The most important (202 units) is situated very close to the theoretical diploid value (198 units); the other (97 units) corresponds practically to half this value. By measurement of nuclei chosen at random, it is clear that the nuclei with a low figure contain only about one-fourth of the total number of the interphase nuclei. When there is no trace of this group in the blastulæ devoid of mitoses (histogram *A*) it seems clear that its appearance is related with the presence of mitoses. This is confirmed by the fact that the small post-telophasic nuclei and most of the swelling nuclei belong to this group. Fifteen metaphase plates were also measured. Notwithstanding the small number of measurements and the low values caused by the extreme condensation of chromatin, the values obtained correspond quite well to the diploid group. The eleven measured daughter plates at anaphase present a frequency maximum which is exactly half the 'diploid' amount.

These results show clearly that, in our material, synthesis of deoxyribonucleic acid does not occur during either prophase or metaphase, but at the beginning of interphase, before, during or after the swelling of the nucleus. Thus they are comparable with the results of J. Pasteels and L. Lison[2], using different material, for deoxyribonucleic acid synthesis during telophase. Other investigators[4,5] on different materials have found deoxyribonucleic acid synthesis to twice the 'diploid' value before or at the beginning of mitosis, so that the 'diploid'-amount is re-obtained after the disjunction of the chromosomes. These discrepancies show clearly that more investigations on the most varied materials are necessary and that it is too soon to draw general conclusions on this problem.

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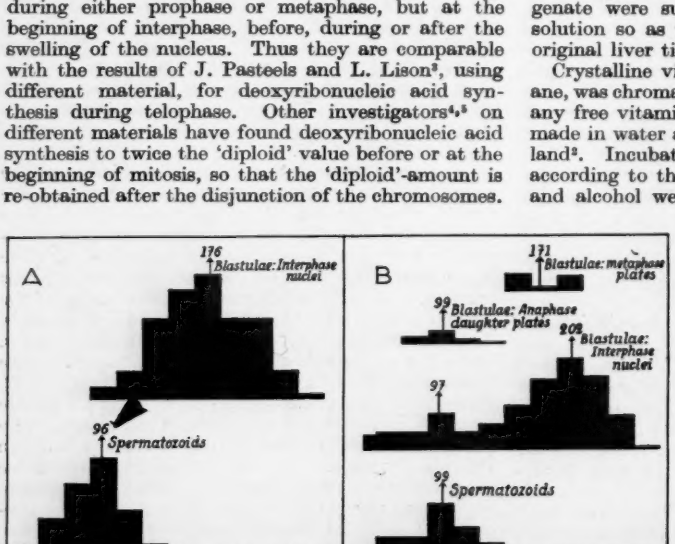

Intracellular Distribution of Vitamin A Esterase Activity in Rat Liver

In 1949, Ganguly[1] observed the presence of an enzyme in pig pancreas capable of hydrolysing vitamin A ester. Recently, McGugan and Laughland[2] have demonstrated vitamin A esterase activity in rat-liver homogenates. Observations in this laboratory fully confirm this report, and show that the activity is located in the microsomal fraction of the homogenate.

Male rats of the University of Southern California strain, raised on a vitamin A - free diet[3], and receiving 15–20 I.U. of vitamin A per week, were sacrificed under light nembutal anæsthesia by direct heart puncture. The residual blood in the liver was removed by perfusion with isotonic saline solution. The excised liver was homogenized in 0·25 *M* sucrose solution by means of the Potter–Elvehjem homogenizer[4], and the homogenate was fractionated by differential centrifugation[5]. All fractions and the whole homogenate were suitably diluted with 0·25 *M* sucrose solution so as to yield equivalents of 200 mgm. of original liver tissue per ml.

Crystalline vitamin A acetate, dissolved in *n*-hexane, was chromatographed through alumina to remove any free vitamin A. A dispersion of the acetate was made in water as described by McGugan and Laughland[2]. Incubation and extraction were carried out according to their method, and the vitamin A ester and alcohol were separated and determined as described by Ganguly and associates[6].

Preliminary experiments demonstrate that the activity is quantitatively present in the microsomal fraction, and that the nuclear, mitochondrial and supernatant fractions are inactive. Omachi and co-workers[7] reported the presence of an esterase (with methyl butyrate as substrate) in the microsomal fraction. Further work to determine the specificity of this enzymatic hydrolysis of vitamin A ester is in progress, and full details will be published elsewhere.

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Assay of Thyroid-stimulating Hormone, Thyroid and Thyroid-like Substances on *Xenopus* Tadpoles

In 1941, Landgrebe and Purser[1] showed that larvæ of *Xenopus lævis* can be obtained in the laboratory all the year round, and suggested that they could be used for assay of thyroid and thyroid stimulating hormone. In 1945 [2], Deanesly and Parkes published a method for assay of thyroid-like activities by oral administration, using these tadpoles at an early stage. Such animals, however, vary a great deal in sensitivity and are too small for satisfactory injection and operative surgery. In the past few years, the anatomy, feeding mechanism, growth, food requirements, development and metamorphosis of the larvæ have been thoroughly investigated. Methods for routine thyroidectomy and injection of extracts have been worked out using larger tadpoles. Methods of husbandry have been devised which reduce individual variation to a minimum, and produce large metamorphically retarded larvæ suitable for assay work (*c.* 400 mgm. with length of hind leg *c.* 0·3 cm.).

Onset and progress of metamorphosis depend upon the amount of active iodine ingested by the larva in its food. Different foods vary widely in their content of active iodine; for example, eight batches of commercial liver powder produce emergence of front limb in similar batches of larvæ in times varying between nine days and more than 105 days.

Several workers, notably Gaddum[3], used larvæ of *Rana temporaria* for assaying iodinated substances by oral administration. Much of this work has been repeated using *Xenopus* larvæ. Sodium thyroxine can be measured in concentrations in the water as low as 3×10^{-8}, and *Xenopus* larva, with its efficient filter-feeding mechanism[4], is an ideal test animal for assays by oral administration.

We have concentrated, however, on a micro-injection technique for the assay of thyroid-like substances and thyrotrophic hormone. Very small volumes of the solutions under test are required, and the method can be used for investigating body fluids. D'Angelo *et al.*[5] and Reineke and Turner[6] used an intraperitoneal injection route in the larvæ of *Rana pipiens*. In *Xenopus* larvæ it is better to inject into the submental lymph space using the inter-hyoideus muscle as a seal. Up to 0·02 ml. of the substance under test may be given.

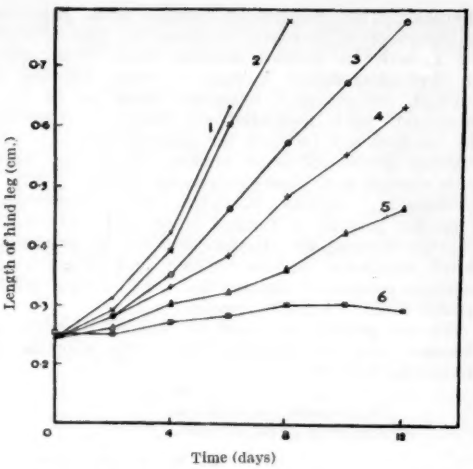

Fig. 1. (1) 0·05 μgm. sodium thyroxine every two days
(2) 0·025 " " " " " "
(3) 0·01 " " " " " "
(4) 0·005 " " " " " "
(5) 0·001 " " " " " "
(6) 0·01 ml. *Xenopus* saline

The effect of different doses of sodium thyroxine on hind leg growth is shown in Fig. 1. Using groups of ten larvæ, amounts of sodium thyroxine as small as 0·004 μgm. in four doses of 0·001 μgm. each in 0·01 ml. *Xenopus* saline can be estimated.

D'Angelo *et al.* used larvæ of *Rana pipiens* for assay of thyrotrophic hormone. They measured the effect on the follicular epithelium of thyroid glands of 'stasis' (starved, non-metamorphosing) larvæ. This method can be used with *Xenopus* larvæ. Fig. 2*b* shows a photomicrograph of a section of the thyroid gland of a *Xenopus* larva which had been starved for two weeks. Fig. 2*c* shows the effect on such a gland produced by human serum from a thyrotoxicosic patient. The follicular epithelium is greatly stimulated, and increase in cell height can be used as a criterion.

We have developed a non-histological method which involves thyroidectomy, a relatively easy

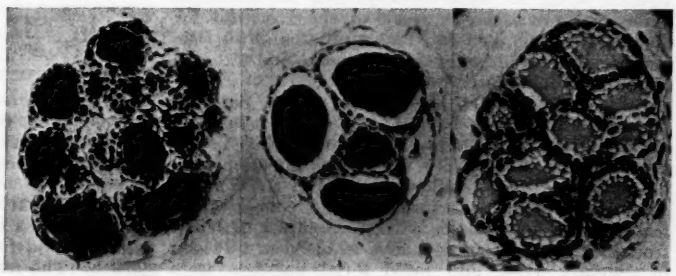

Fig. 2. Transverse sections of thyroid gland of *Xenopus* larva
(*a*) Normal gland of pre-metamorphic larva. Stained hæmatoxylin (Heidenhain). × 133
(*b*) Gland of larva starved 14 days. Stained hæmatoxylin (Heidenhain). × 180
(*c*) Gland of starved larva after injection of serum from thyrotoxicosic patient. Stained hæmatoxylin (Ehrlich) and eosin. × 250

operation in the transparent *Xenopus* larva. Injection of thyrotrophic hormone increases the rate of hind-leg growth in normal animals with little effect in thyroidectomized animals. Some batches of purified thyrotrophic hormone seem to be contaminated with iodinated substances. However, the method can be used for assay of the extracts, whether active iodine is present or not, by using both normal and thyroidectomized larvæ.

Similarly, thyroid hormone and thyrotrophic hormone, present in human blood and body fluids of other animals, are effective and can be estimated. Work continues on the thyroid and thyrotrophic hormone content of human blood, which may differentiate cases of hyperthyroidism.

We are greatly indebted to Messrs. Armour, of Chicago, and to Organon, Ltd., for supplies of thyrotrophic hormone.

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Isolation of a New Strain of *Plasmodium knowlesi*

Sinton and Mulligan[1] isolated a virulent strain of *Plasmodium knowlesi* from a mixed infection of *P. knowlesi* and *P. cynomolgi* in *M. irus* monkeys imported into Calcutta from Singapore; it was possible only after rapid serial passages through rhesus (*M. rhesus*) monkeys. Eventually, the strain of *P. knowlesi* was being maintained for chemotherapeutic and other studies by the Malaria Institute of India, Delhi, and by some laboratories in Great Britain and the United States.

By 1952, these institutions had either completely lost the strain or it was found to be attenuated, as reported by Jaswant Singh, Ray and Nair[2]. Attempts have been made in recent years to isolate again a virulent strain in rhesus monkeys from *M. irus* from Malaya, through the courtesy of the Institute for Medical Research, Federated Malay States. From the materials received, only *P. cynomolgi* and *P. inui* could be demonstrated[3].

Early this year, Dr. Edeson was able to detect a plasmodium which he believed to be *P. knowlesi* in a Kra monkey (*M. irus*) obtained from the Nuri Valley near Tampin (Malaya). When the infection was passaged to rhesus monkeys sent from the Malaria Institute of India, the intensity and course of infection were found to be severe. Samples of blood from two such rhesus monkeys were flown to Delhi in January 1953, and rapid serial passages were made. Inoculations were given intravenously or intraperitoneally, the dose of inoculum varying from 1×10^6 to 50×10^6. The prepatent period varied from one to three days when infected blood was injected intraperitoneally, and from four hours to forty-eight hours after intravenous injection. When patency was fully established, irrespective of the dose of inoculum and the route of injection, in all cases there was rapid rise in parasite counts. In most cases it reached 90–96 per cent cell infection prior to death, which invariably occurred five to seven days after the appearance of parasites in the peripheral circulation. Of fifty animals studied, hæmoglobinuria was observed in about ten. Extreme anæmia and rapid prostration were dominant features in all cases.

Differential parasite counts[4] from blood smears taken every four hours for five to seven days during the course of infection have revealed a clear-cut 24-hr. periodicity.

The morphology of the parasite resembles closely the description given by Sinton and Mulligan[1]. Besides, band forms similar to those reported by Brug[5] and a few other characteristics have been observed, and are being studied in detail.

To eliminate the co-existence, if any, of any other species, spleens were removed from some monkeys before or after inoculation. This procedure was found useful by Jaswant Singh *et al.*[3] and Jaswant Singh and Ray[6].

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Toxicity of Radiostrontium in Monkeys

As a preliminary to a long-term investigation, eight monkeys have been injected with large doses of pure strontium-90 (25 years half-life) in equilibrium with its short-lived decay product yttrium-90. There is a higher toxicity and greater retention than in other species of animals[1]. Results are summarized below:

Injection dose (mC./kgm.)	Survival time (days)
2·0	13 15
1·0	21 23 24 25
0·5	35 56

All the animals apparently died from anæmia; the hæmoglobin, red-blood cell count and packed-cell volume fall in a remarkably consistent manner; the white-cell count always falls before the red-cell count.

The amount of radiostrontium retained in the body at death was estimated from autopsy radioactivity analysis and from the total activity excreted before death. The retention varied between 90 and 66 per cent. The relative rate of excretion is higher for animals receiving a lower dose. The logarithm of the strontium-90 activity of the daily excreta plotted against the logarithm of the number of days after

injection gives a straight line[1] of small slope, with slightly more activity in fæces than in urine. Fresh specimens were assayed for strontium-90 and for yttrium-90 and the relative amount of yttrium excreted was found to be greater for specimens taken a long time after the injection. Details of diet and full hæmatological, histological and radioactivity reports will be published later.

Our thanks are due to Profs. E. E. Edwards and H. E. Huntley and Mr. A. H. Booth, of this College, for their encouragement, and to Dr. J. F. Loutit, Dr. R. M. Mole and the Medical Research Council for their advice and financial support.

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Discovery of Iron in Tunicin-forming Blood Cells of an Ascidian

Henze[1] was the first to show that vanadium is present in the blood of certain ascidians. Webb[2] demonstrated that the metal is accumulated by the primitive families but not by the more specialized families of the Ascidiacea. Also he showed that the vanadium chromogen is located in a special type of cell which he termed a vanadocyte.

Pyura stolonifera (Heller), a member of the relatively specialized family Pyuridæ, is a common zoning animal found on the rocky shores of New South Wales and southern Queensland[3]. Blood was taken from the large vessels in the tests of these animals. Morula-shaped corpuscles, fundamentally similar in appearance to the green vanadium-containing cells of the family Ascidiidæ, comprised between 70 and 75 per cent of the total number of corpuscles. Both spectrographic examination of the ashed blood and colorimetric analysis using phosphotungstic acid gave negative results for vanadium.

The blood was then tested for other metals and it was discovered that organically bound iron was present. This was in the ferrous condition and, as evidenced by histochemical staining, was confined to the morula-shaped corpuscles. Blood from twenty individuals was pooled and centrifuged. The concentration of iron in aliquots of the pooled blood corpuscles was estimated colorimetrically using o-phenanthroline. The iron content of the corpuscles averaged approximately 0·5 mgm. per cent of their dry weight. Further, it was established that there was much individual variation in the iron content of the blood, which was correlated with variation in the corpuscle count from individual to individual.

The blood did not exhibit absorption bands in the visible region of the spectrum at room temperature. Additional observations suggest that the iron chromogen did not have a respiratory significance.

When the corpuscles were cytolysed in distilled water, an orange-coloured suspension was obtained and this contained the iron compound. This was non-dialysable and resembled the vanadium chromogen of other tunicates in its strongly reducing properties.

It would appear that in *Pyura stolonifera* an iron compound is present in high concentration in certain blood corpuscles, and that it may be physiologically equivalent to the vanadium chromogen occurring in primitive tunicates.

Additional work upon the species is proceeding, especially with reference to tunicin formation. In subsequent publications the synthesis of tunicin from the cytolysing contents of the morula-shaped cells will be described.

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Folin-Wu Prepared Blood-Group Specific Substance *A*

A simple method for the preparation of blood-group specific substance *A* from Difco's neopeptone by means of the *Folin-Wu* technique of preparing a protein-free filtrate was recently reported[1]. Preliminary chemical, as well as inhibition of isoagglutination, studies were made of products prepared from both hog pepsin and neopeptone[2].

A detailed study has been made[3] of the products prepared from the above substances, with particular attention to the chemical, electrophoretic and paper chromatographic properties.

Total nitrogen (micro-Kjeldahl) and carbohydrate (orcinol method) for products prepared from both pepsin and neopeptone indicate a great deal of agreement in the carbohydrate values—8·2 per cent for the former and 8·7 per cent for the latter. The total nitrogen for pepsin (8·7 per cent) was much higher than in the case of neopeptone (4·8 per cent).

The electrophoretic studies showed considerable variation in the mobilities, and no more could be deduced except that a major and minor component existed. There was no indication of isoelectric points.

Two-dimensional paper chromatography showed fifteen ninhydrin-positive areas. There were variations depending upon the source material. The blood-group specific substance prepared from pepsin appeared to have histidine instead of the hydroxyproline of the neopeptone product. Methionine appeared only in the pepsin product. Galactose, fucose, rhamnose and glucosamine were detected in both products with one-dimensional chromatography.

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Purification of Secretin by Freezing Out of Impurities from Methanolic Solution at −80° C.

We recently described a method for the purification of secretin, based on the repeated isoelectric precipitation of impurities from solutions of crude secretin in methanol[1]. The final, lyophilized product had an activity varying, in different preparations, from 600 to 900 cat units[1] per mgm. ash-free substance.

We have found that a further twofold increase in activity may be achieved by dissolving the purified substance to a 1 per cent solution in absolute methanol, adjusting the *p*H to 7·0 and allowing to stand at − 80° C. for a couple of days. An ash-free fraction, comprising about nine-tenths of the protein matter originally present in solution, and including about seven-tenths of the secretin activity, is precipitated. After removal of this precipitate, the purified product is precipitated from the solution with several volumes of water-free ethyl ether.

The product comprises about one-tenth of the protein matter originally in solution, and contains from two- to three-tenths of the secretin activity, as well as practically all the ash. Its activity is about 1,500 cat units per mgm. ash-free substance.

In a few cases we have removed the ash by means of the ion-exchange resins 'Dowex 50' and 'Dowex 2' before dissolving the secretin in absolute methanol. In one case this led to a final product with the activity expected for an ash-free preparation, that is, 1,500 units per mgm. In the remaining cases, however, a considerable loss in activity occurred during treatment of the secretin with the resins.

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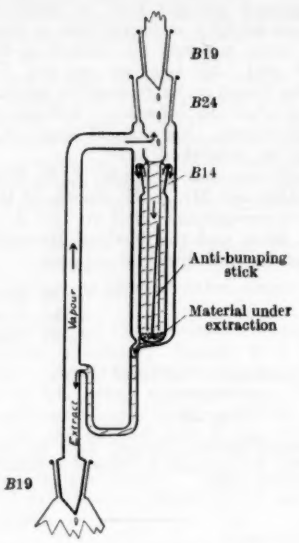
A Micro Lipid Extractor

In the course of studies of the phospho-compounds of bacteria, an apparatus was designed to make possible the quantitative extraction of phospholipid by the method of Reichert[1] on a micro scale. I have been prompted to give a brief description of this apparatus by other research workers in this laboratory who have found it useful[2].

The method of Reichert consists in heating the material to be extracted with methanol, evaporating to dryness and extracting the lipid with dry ether in a Soxhlet apparatus. The lower limit to the amount of material which can be handled by this method is set by the losses which accompany the transfer to and from the extraction thimble. The amount which could be handled was reduced to a level determined by the gravimetric error by eliminating the necessity for transfer. Both the preliminary treatment with methanol and the ether extraction were carried out in *B* 14 'Quickfit' tubes into which samples were initially weighed. The diagram shows the method of ether extraction, the rate of flow of ether being regulated at about 2 ml. per minute.

The determinations of total lipid contents of a large number of bacteria and bacterial fractions[3] have been found to be reproducible to within the limit of the gravimetric error using 5–50 mgm. of material containing 0·3–5 mgm. of lipid and weighing with an air-damped aperiodic balance reading to 10 μgm.



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Toxicity Studies on Silicone Rubber and Other Substances

Tissues which are grown in a culture medium or perfused must not be brought into contact, directly or indirectly, with material which is toxic, and it is preferable if apparatus in use can be sterilized by dry heat. Vulcanized rubber tubing, lubricant greases, and paraffin-lined tubes which are at present used in this work have disadvantages.

Vulcanized rubber tubing is toxic because of its content of sulphur and talc. It requires special treatment before use, does not withstand the usual temperature of a dry heat oven, and must therefore be sterilized by some other means. Lubricant greases which might be used have too low a melting point for sterilization *in situ* on a ground-glass joint. Paraffin-lined tubes are satisfactory for storing plasma but require constant recoating as they can only be used once.

It was thought that by replacing the above with silicone compounds there would be a considerable reduction in the amount of routine laboratory work. These compounds are relatively inert, chemically and physically, and if, in addition, they could be proved to be non-toxic, this would ensure an advance in technique. Silicone rubber, obtainable in the form of tubing, is flexible and unaffected by repeated baking in a dry heat oven. Silicone greases remain

viscid over a wide range of temperature, including 160° C. Silicone-lined tubes withstand dry heat and are relatively durable, not requiring to be recoated each time they are in use.

The toxicity of these substances and of fluids stored in silicone-lined tubes towards cells maintained *in vitro* was tested. The cells used included fibroblasts derived from the heart, nerve cells from the spinal cord, epithelial cells from the intestine, and cells from the spleen, all obtained from chick embryos. A total of seven hundred explants, including control cultures, was studied by the hanging drop method. Control and experimental cultures showed a close similarity in respect of rate of growth, contractility of muscular elements, cytological appearance and mitotic activity as determined by counts. These silicone compounds would appear, therefore, to be of value in tissue culture work.

As these materials are available in different grades, the sources of the varieties used in the tests are given below. Silicone rubber: *DSR* 210 (Dunlop Rubber Co., Ltd.) or 181 (Midland Silicones, Ltd.); silicone greases: stopcock and high vacuum (Dow Corning); silicone fluid: *M* 440 (Imperial Chemical Industries, Ltd.) for coating glass tubes to render them water-repellent. Preliminary tests on eleven other grades of silicone rubber with differing physical properties, such as elasticity, suggest that some of these may also prove to be non-toxic. The reaction of the tissues of the intact animal to some of them is now under investigation.

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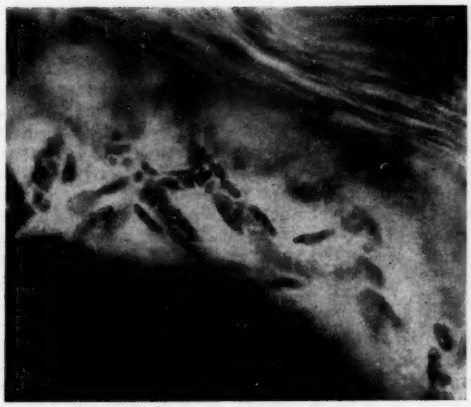
Use of Cyanol in the Study of Blood-vessels in Sheep Skin

As one approach to the problem of the nourishment of the growing wool fibre in its follicle, a detailed study of the distribution of blood-vessels in the skin of sheep and the blood supply to the wool follicle has been commenced in these laboratories.

Because injection techniques are obviously unsuitable for adult animals, a staining method was sought. Various stains for hæmoglobin have been used to visualize blood-vessels in histological sections (for example, that of Pickworth[1]), but these have usually involved long and laborious procedures. The simple and rapid method of Dunn[2], which stains hæmoglobin blue, nuclei red and cytoplasm pink, has not to my knowledge been used previously for this purpose. A slightly modified form of Dunn's method is being used, with good results, on thick sections, and it is thought that this might be of interest to other histologists. Whole-mount preparations have also been made by staining small pieces of skin in cyanol alone.

Dunn recommends fixation in 4 per cent formaldehyde solution buffered to *p*H 7·0. Although buffered fixative was not used here, the formalin was neutralized with sodium carbonate before the fixative (formol–saline) was prepared. It was found, however, that some specimens fixed in formol–saline which had not been neutralized in this way stained satisfactorily. According to the usual practice in this laboratory, the material was not taken below 70 per cent alcohol, after fixation in 5 per cent formol–saline.



Photomicrograph showing part of the capillary network around a wool follicle (dark area to the left). The light area around the capillaries is an artefact caused by the shrinkage, away from the follicle, of the connective tissue at the right. × 680

Although Dunn states that the method is useful for wax sections, better staining was obtained with frozen sections, which show less shrinkage and are also quicker to prepare. Immediately after cutting at 100 microns on the freezing microtome, the sections are placed in 70 per cent alcohol, then stained in cyanol for up to five minutes and rinsed in 70 per cent alcohol (which removes cyanol from regions other than the red blood corpuscles). After this they are counter-stained with safranin for at least five minutes. The latter stain is differentiated in 70 per cent alcohol, and the sections are dehydrated in absolute alcohol, cleared in methyl benzoate and mounted in 'Distrene'.

These thick sections are excellent for demonstrating the distribution of blood-vessels and the general structure and arrangement of wool follicles and their accessory structures in the skin. Although the cyanol only shows blood-vessels when they are full of blood, this disadvantage is overcome because the safranin stains their walls, thus making them visible when empty.

Cellular detail of the vessel walls in the dermal connective tissue (the fibres of which are unstained) is very clear considering the thickness of the sections; different kinds of vessels (for example, arteries and veins) can be distinguished by the differences in structure of their walls. Cellular detail can also be seen in the glands; these finer details are, however, less easily seen in the thicker follicles, which are, of course, stained more densely.

Owing to their clarity, these preparations also show well melanin-containing cells. These pigment cells have been observed in the dermis of sheep skin and around blood-vessels as well as in the epidermis, around sebaceous glands, and in the outer root sheaths of follicles.

My thanks are due to Mr. H. M. Appleyard and Miss M. E. A. Perkin for preparing the photomicrograph.

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Preparation of Dry Clay-Gels by Freeze-drying

In a recent discussion on clay–water relationships[1], it was reported that Prof. U. Hofmann had prepared dry clay-gels by a freeze-drying technique. I have also made a number of samples of montmorillonite in 20–30 gm. batches by a similar method. A 20 per cent aqueous dispersion of the clay, after purification and saturation with the required base, was frozen so as to form a layer about 5 mm. thick over the inner surface of a 2-litre bolt-head flask, which was then rapidly evacuated to a pressure of less than 1 mm. mercury, the evaporated water being trapped by calcium chloride towers. The final product was a curved sheet of pith-like material of fibrous structure which tended to fracture normally to the surface and had properties similar to those of Prof. Hofmann's product. The bulk density was 0·12 gm. per c.c. as compared with a density of 0·82 for the original powdered bentonite. Attempts to prepare similar gels of kaolin and a soil clay fraction failed since the dry products fell to a fine powder.

Nitrogen areas of calcium, sodium and hydrogen montmorillonite obtained by the standard Brunauer–Emmett–Teller method were 70, 49 and 58 m.^{2} per gm. respectively. The area of the calcium-saturated clay was the same as that of the original powder. During the preliminary degassing, which was carried out at 10^{-5} mm. mercury for 100 hr., the gels became considerably lighter in colour and gradually lost their structure, tending to fall to a fine powder. A similar loss of structure has been observed during long heating at 110° C. and after storage over phosphorus pentoxide. These observations suggest that the clay crystals are held in a micelle by hydrogen bonding with water molecules.

Curves representing the swelling at different relative humidities were obtained by measuring the elongation of pellets of compressed clay exposed in desiccators. The curve for calcium montmorillonite has two plateaux, and indicates that swelling takes place in two clearly defined stages corresponding to expansion of the lattice from 9 A. to 12 A. and from 12 A. to 15 A. The curves for hydrogen and sodium montmorillonite each exhibit only one plateau, and swelling seems continuous at higher humidities. No swelling was observed with kaolin or soil clay fractions. These results in general are in agreement with those obtained by Hendricks, Nelson and Alexander[2] using X-ray analysis.

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[1] *Nature*, **171**, 682 (1953).
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The Serpentine Minerals

Selfridge[1] has shown that the serpentine minerals can be divided by the evidence of their X-ray powder patterns into two main groups, chrysotilic and antigoritic. Five distinct varieties from each group which show varying degrees of fibrous or splintery texture have been examined in this department, using oscillation photographs to determine in each case which crystallographic direction lies parallel to the fibre axis.

The chrysotilic specimens, including schweizerite, marmolite and chrysotile asbestos itself, all have a repeat distance of 5·3 A. parallel to the fibre axis, whereas in the antigoritic varieties, including picrolite, picrosmine and antigorite (Hokitika), the repeat distance along the fibre axis was found to lie between 9·2 and 9·3 A. Furthermore, antigorite from Mikonnui, New Zealand, was described by Aruja[2] as having a fibrous texture parallel to the *b* axis, and platey single crystals of this variety have a marked {100} cleavage in addition to the expected {001} cleavage.

The basic structure of these minerals is assumed to be that of a magnesium analogue of kaolinite (having cell dimensions approximately $a = 5{\cdot}3$ A., $b = 9{\cdot}2$ A., $c = 14{\cdot}6$ A., $\beta = 91°$–$93°$), and the fibrous nature of chrysotile asbestos is attributed to cylindrical curvature of the sheet units about the *a* axis, in some cases forming hollow tubes[3]. The results presented here would suggest that in the fibrous antigoritic varieties curvature has taken place about the 9·2-A. axis.

It is also of interest that several workers have noted in fibre photographs of chrysotile very weak subsidiary layer lines which correspond to a repeat distance of 9·2 A.[4].

Suggestions have been made that platey antigorite differs from chrysotile in certain chemical features, for example, replacement of magnesium by aluminium, or a low (Mg, Al) : (Si, Al) ratio, which allow the tetrahedral and octahedral layers of a sheet to fit together without bending. In view of the structural distinction outlined above, it seems likely that, with a given chemical composition, two types of serpentine mineral may exist, one chrysotilic and one antigoritic, with [100] or [010] as fibre axis respectively. Which type occurs in a given instance may depend upon the physical conditions prevalent at the time of crystal growth, for example, anisotropic pressure and orientation of parent material. With increasing radius of curvature these two types may converge to give a platey non-fibrous variety such as the one from Caracas, Venezuela[5].

Finally, it is worth mentioning that the possibility of curvature about the *b* axis favours an explanation of the multiple *a* axis of antigorite (Mikonnui) along lines similar to those suggested by Onsager[6].

Further investigation, by X-ray and chemical methods, of this and related problems is in progress in this Department. I am grateful to Prof. W. A. Deer and to Dr. G. D. Nicholls for helpful advice and discussion.

J. Zussman

Department of Geology,
University of Manchester,
Manchester 13. Feb. 12.

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Recombination without Sexual Reproduction in *Penicillium chrysogenum*

The technique devised by Pontecorvo and Roper[1,2] for genetic analysis outside the sexual cycle in filamentous fungi and applied to the imperfect fungus *Aspergillus niger*[3,4] has now been successfully adapted by us to another imperfect fungus, *Penicillium chrysogenum*, the species used for penicillin production.

Starting from strains ultimately tracing back to Q176 *Wis.*, which has green conidia and no growth-

factor requirements ('prototroph'), strains with yellow or white conidia, with one or two different growth-factor requirements ('auxotrophs'), and with normal or stunted ('dwarf') growth were obtained by various ultra-violet irradiation steps. The strains used were: *22y dw*-1, yellow conidia, requiring hypoxanthine, 'dwarf'; *7w dw*-4, white conidia, requiring cystine, 'dwarf'; *22y* 13, yellow conidia, requiring hypoxanthine and methionine, normal growth; *7w* 16, white conidia, requiring adenine and cystine, normal growth.

'Balanced' heterokaryons were synthesized by mixed inoculation of *22y dw*-1 + *7w dw*-4, and of *22y* 13 + *7w* 16. The heterokaryons were not as easily obtained in this species as in the two previously used, due mainly to its extremely slow growth and great 'staling' reaction. As expected, the heterokaryons differed from the component strains in being 'prototrophs', that is, able to grow on unsupplemented Czapek–Dox medium ('minimal medium') and, in the case of the first combination, in having normal, not stunted, growth habit. These heterokaryons were kept by transfers of hyphal tips on minimal medium. They produced a mixture of yellow and white conidia, turning greenish with age, a situation more like that of heterokaryons in *Aspergillus nidulans*[5] than that in *Aspergillus niger*[4]. The overwhelming majority of the conidia from the heterokaryons gave origin to colonies of either one or the other component types.

Plating on minimal medium of conidia from the heterokaryons at densities of 10^6/dish gave from 0·3 to 4 green-spored colonies per 10^7 plated conidia. Furthermore, about 1 in 100 of the few heterokaryotic colonies arising anew from these platings gave a green sector. Isolation of the green colonies, and of the green sectors from the heterokaryotic colonies, followed by purification by single conidium micromanipulation, led to the establishment of heterozygous diploid strains.

That these green-spored strains were actually diploid and heterozygous was shown by: (1) their 'wild type' phenotypes, that is, green conidia, normal morphology and prototrophy; (2) the fact that the majority of single conidia bred true, differently from the single conidia of heterokaryons which gave origin to colonies of either one or the other parental types; (3) the diameter of their conidia, larger than the wild type or the heterokaryons; (4) segregation and recombination as presently described.

After purification, by single conidium isolation, of diploid $\frac{22y\ dw\text{-}1}{7w\ dw\text{-}4}$, its conidia were plated on fully supplemented medium. 1,010 colonies from this plating were isolated and classified as to colour, morphology and requirements with the following results.

Green, adenine-requiring, normal morphology	1
Yellow prototroph, normal morphology	2
Yellow prototroph, dwarf	2
Yellow, adenine-requiring, dwarf	1
White prototroph, normal morphology	12
White prototroph, dwarf	6
Green prototroph, normal morphology	964
Green prototroph, dwarf	5
Non-sporing, prototroph, normal morphology	17
Total	1,010

A proportion of the 1,010 colonies showed sectors, some yellow, some white, and some non-sporulating or with growth habit different from that of the mother colony. Isolation from 21 of these sectors, each from a different colony, and further tests gave: 14 white and 5 yellow prototrophs, with normal morphology; 1 yellow prototroph, dwarf; and 1 green, cystine-requiring, with normal morphology. Isolation of yellow and white sectors from the green adenine-requiring strain mentioned in the list above gave adenine-requiring strains, yellow and white respectively. Thus eleven new different phenotypes (out of a possible minimum of twenty-one) have already been obtained.

A similar analysis of diploid $\frac{22y\ 13}{7w\ 16}$ gave analogous results.

This work, preliminary as it is, is sufficient to show that heterozygous diploid strains can be synthesized in *P. chrysogenum* by means of Roper's[6] technique, and that these diploids give origin to strains associating and recombining the properties of the starting strains.

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G. Sermonti
Department of Genetics,
University of Glasgow;
and
International Centre for Microbiological Chemistry,
Istituto Superiore di Sanità,
Roma. June 15.

[1] Pontecorvo, G., and Roper, J. A., *J. Gen. Microbiol.*, **6**, vii (1952).
[2] Pontecorvo, G., and Roper, J. A., "Advances in Genetics", **5**, 218 (1953).
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[4] Pontecorvo, G., Roper, J. A., and Forbes, E., *J. Gen. Microbiol.*, **8**, 198 (1953).
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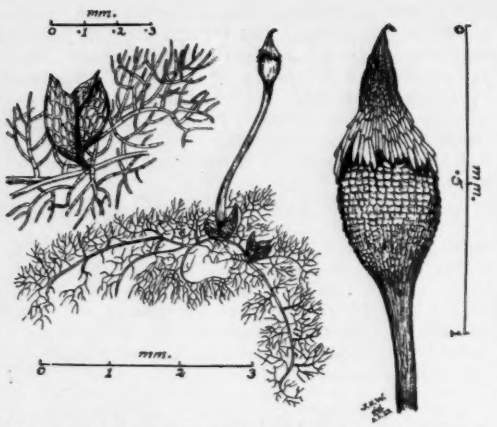
Nemataceæ, a Moss Family New to Australia

The Nemataceæ embraces only two known species, namely, *Ephemeropsis tjibodensis* Goebel em. Fleischer, which is epiphyllous, ranging from Siam through the Indonesian Islands to New Guinea, and *E. trentepohlioides* (Renner[1]) Sainsbury[2]—until now believed endemic in New Zealand, where it is scattered through both islands, occurring on bark and twigs (of *Rubus*, *Leptospermum*, *Fuchsia* and *Coprosma* spp.). Both mosses are small and inconspicuous, with very remarkable gametophytes consisting almost entirely of matted, freely branched protonemal filaments which creep over the substrate. Normal foliage is represented by a single series of three or four minute nerveless leaves at the base of each female inflorescence (or seta, which may be several millimetres long). The differences between these species are fully discussed by O. Renner[1] and G. O. K. Sainsbury[2], and it seemed likely that one or other would eventually be found in eastern Australia.

On December 13, 1952, while examining mosses in virgin beech forest along the Florentine Valley west of Mt. Field National Park, Tasmania, I collected some dead beech twigs (*Nothofagus cunninghamii*) bearing festoons of epiphytic musci, including *Weymouthia mollis*. Later, in the herbarium, a minute unfamiliar capsule (with calyptra attached) was detected on one branchlet. It proved to be that of an *Ephemeropsis*; but most careful searching over all the other *Nothofagus* twigs failed to disclose a second capsule, or even another plant, of this intriguing moss. So, short of destroying the solitary sporophyte, it was impossible to study either peristome or spore details. Mr. Sainsbury (of Wairoa,



Ephemeropsis trentepohlioides (Renner) Sainsbury, 1951, drawn from a Tasmanian specimen

N.Z.) has kindly examined my Tasmanian collection and pronounces it identical in vegetative characters with the New Zealand *E. trentepohlioides*; he believes that an important extension in the known range of that species has now been established. The discovery of additional Australian material on beech, and probably other rain forest trees or shrubs, is much to be desired.

J. H. Willis

National Herbarium,
South Yarra, Victoria.
Feb. 2.

[1] Renner, O., *Ann. Jard. Bot. Buitenzorg*, **44**, 79 (1934).
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Relation of Witchweed (*Striga*) to Fertility in Tropical Soils

Much is written upon the subject of soil exhaustion in Africa, and it seems to be generally accepted that the soils of the tropics require careful management, including frequent periods of rest, if fertility is to be maintained. In the great clay plains of the Sudan[1] in particular, it has been emphatically stated that uncontrolled continuous cultivation of land around water points and villages is responsible for the poor crops and general poverty of the villagers, and that only the provision of new villages at new water points, where cultivation can be rigidly controlled, can solve the problem. It cannot be doubted that soil erosion is responsible for reduction of yields in some cases. The question then arises, what is the reason for the very markedly poor yields of the grain and fodder crop, *Sorghum vulgare*, Pers., on the village cultivations, where soil erosion is not marked? The answer in the northern and central Sudan seems to be the root parasite *Striga hermontheca*, Benth., which is prevalent in more or less degree wherever this crop is grown, being indigenous as a parasite of the native grasses. By suitable treatment with hormone weed-killers[2] it has been shown that it is possible to kill much of the *Striga* and bring about very considerable increases in yield on irrigated land. During the 1952 season, an experiment was carried out on a piece of village land near Gedaref, in the eastern Sudan, which has been under cultivation for longer than can be remembered by the oldest inhabitants. The result was that sorghum on the untreated plots yielded 427 lb. of heads to the acre, whereas that on plots treated against *Striga* yielded 1,183 lb. of heads to the acre (P better than 5 per cent). This latter would be a fairly good yield for newly opened land.

It is interesting to note that one of the criticisms which has been levelled against the practice of this treatment for *Striga* control is that it will make possible cultivation without rotation on village lands. If, however, as here, the removal of *Striga* is capable of raising the yield on so-called 'worn-out' lands to a level comparable with yields obtainable from newly opened land, the reply might be made by asking whether the land is worn out, or merely over-parasitized? Only further experimentation will show whether, as a recent summary[3] states, *Striga* is only serious on worn-out soils, or whether, as I suggest, the 'wearing-out' is due to *Striga*, on these lands of marginal rainfall.

K. Wilson Jones

Sudan Dept. of Agriculture and Forests,
Research Farm,
Wad Medani.
Feb. 15.

[1] Jefferson, J. H. K., *Sudan Notes and Records*, **30** (1949).
[2] Andrews and Wilson Jones, Annual Report, Research Division, Department of Agriculture and Forests, Sudan Government, 1947–48 (unpublished). Wilson Jones, *Empire J. Exp. Agric.* (April 1952).
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An Effect of Parasitism on *Balanus balanus* (L.) da Costa

The parasitism of barnacles of many species by various isopods, gregarines and trematodes, often with the resultant castration of the host, is well known. Recent observations on *Balanus balanus* collected in the Firth of Clyde, at a depth of about 20 metres, have shown that parasitism may not result in complete castration, but only in non-liberation of the nauplii.

This barnacle spawns during the spring: a collection was made when the main spawning period was known to have ended, and several hundred individuals of all size-groups examined for the state of the ovaries. Only a single individual was found with embryos, the remainder being either immature or spent. Further examination showed this individual to be heavily parasitized by a protozoan, and although not specifically identified it seems probable that it was a gregarine, these being known to be of common occurrence in other *Balanus* species[1].

On teasing out into sea water, the liberated stage I nauplii appeared to be quite normal, swimming vigorously. However, within a few minutes almost all the nauplii (stage I) had moulted to give normal stage II nauplii.

It would seem, therefore, that the presence of the parasite, while not effecting castration, had prevented normal release of the nauplii, and that development of the latter had continued to some extent within the mantle cavity, so that on release extremely rapid moulting to stage II took place.

H. Barnes

The Marine Station,
Millport,
Isle of Cumbrae.
Feb. 23.

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FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Tuesday, July 21

ROYAL ASTRONOMICAL SOCIETY, in co-operation with King's College, Newcastle upon Tyne (University of Durham), and the Newcastle upon Tyne Astronomical Society (at the Newcastle upon Tyne Royal Grammar School, Eskdale Terrace), at 8.15 p.m.—Prof. W. M. Smart: "The Origin of the Earth".*

Wednesday, July 22

ROYAL ASTRONOMICAL SOCIETY, in co-operation with King's College, Newcastle upon Tyne (University of Durham) (in the Stephenson Building, King's College), at 4.30 p.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DEMONSTRATORS (with engineering degree or equivalent, and preferably with industrial experience) IN MECHANICAL ENGINEERING, to assist in organization, preparation, and control of work to final B.Sc.(Eng.) standard in materials, metallurgy, meteorology, heat engines and aerodynamics laboratories—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (July 25).

LECTURER (Grade III or Grade II) IN THE DEPARTMENT OF ORGANIC CHEMISTRY—The Registrar, The University, Bristol 8 (July 25).

ASSISTANT EXPERIMENTAL OFFICER (with general certificate of education (advanced level) or pass degree in biological subjects, and preferably with experience in biochemistry and/or genetics) to work in Edinburgh on research into the nutritional requirements of *Drosophila* and the genetic control of these needs—The Secretary, Agricultural Research Council, Cunard Building, 15 Regent Street, London, S.W.1 (July 27).

GAS PLANT MANUFACTURER'S DEVELOPMENT COUNCIL SCHOLARSHIP—The Registrar, The University, Leeds 2 (July 30).

ANALYTICAL CHEMIST, Senior Experimental Officer grade (with degree in chemistry or equivalent qualification and experience in analytical work), to collaborate with plant breeders and grassland agronomists in the routine analysis of plant material used in breeding and research work, and to take charge and responsibility for the establishment of a chemical laboratory—The Secretary, Welsh Plant Breeding Station, Penglais, Aberystwyth (July 31).

ASSISTANT EXPERIMENTAL OFFICER IN THE MARINE LABORATORY, Aberdeen, for investigation of physical conditions in the sea (water movements, currents, temperature, salt content, etc.) in relation to fishery biology, with active participation in the collection of data at sea on a research vessel or fishing vessel—Establishment Officer, Scottish Home Department, Room 364, St. Andrew's House, Edinburgh 1 (July 31).

DEMONSTRATOR IN BOTANY (preferably wanting research experience in cytology or plant biophysics)—The Registrar, The University, Leeds, 2 (July 31).

LECTURER IN BOTANY, and a DEMONSTRATOR IN BOTANY—The Registrar, The University, Leeds 2 (July 31).

RESEARCH ASSISTANT IN THEORETICAL PHYSICS—The Registrar, King's College, Newcastle-upon-Tyne (July 31).

ASSISTANT LECTURER IN AGRICULTURAL CHEMISTRY (with special qualifications in animal nutrition), and a DEMONSTRATOR IN AGRICULTURAL CHEMISTRY—The Registrar, The University, Nottingham (August 1).

ASSISTANT LECTURER IN AGRICULTURE—The Registrar, The University, Reading (August 1).

ASSISTANT LECTURER IN PETROLOGY—The Registrar, The University, Nottingham (August 1).

MATHEMATICIANS (Scientific Officer Class, with first- or second-class honours degree in mathematics or equivalent, and Experimental Officer Class, with H.S.C. (Science) or equivalent) in Ministry of Supply Research and Development Establishments at Farnborough, Amesbury and Malvern, for work in aerodynamics, aircraft structures, ballistics, radio or radar, high-speed electronic calculating machines—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.117/53A. (August 1).

DEMONSTRATOR (with honours degree in chemistry or biochemistry) IN THE DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY—The Dean, St. Thomas's Hospital Medical School, London, S.E.1 (August 4).

PHYSICISTS (with good honours degree or equivalent) IN THE PHYSICS DEPARTMENT of the Central Research Establishment, Stoke Orchard, Cheltenham, Glos, for fundamental and other studies in connexion with technical processes of coal preparation and treatment—The National Coal Board, Central Research Establishment, Cheltenham, Glos, quoting TT/652 (August 5).

SUPERINTENDENT (Deputy Chief Scientific Officer) (with first- or second-class honours degree in a science subject or equivalent qualification) in the D.S.I.R. Metrology Division, National Physical Laboratory, Teddington—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting 84228/53 (August 6).

LECTURER IN BIOCHEMISTRY (preferably with special experience in biochemistry of micro-organisms)—The Secretary, The University, Aberdeen (August 7).

PLANT BREEDER (Fruit) (Scientific Officer grade or Senior Scientific Officer grade) in the University of Bristol Research Station, Long Ashton, Bristol—The Registrar and Secretary, The University, Bristol 8 (August 8).

SENIOR BIOCHEMIST IN THE DIVISION OF PLANT INDUSTRY, Commonwealth Scientific and Industrial Research Organization, Canberra, for investigations into carbohydrate and protein metabolism, the role of micronutriments, the action of growth substances and the biochemistry of cell differentiation, with opportunity for further research development in which collaboration with workers in the fields of plant genetics, physiology and microbiology may be a special feature—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 130/189 (August 29).

LECTURER, Grade I or Grade II (with university degree with physics a major subject) IN PHYSICS, at the University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 31).

LECTURER IN GEOLOGY (with special qualifications and experience in mineralogy and petrology, or in palæontology, or in stratigraphy)—The Registrar, University College, Keele, Staffordshire (August 31).

SCHOLARSHIPS IN DEMOGRAPHY, GEOGRAPHY and STATISTICS, including mathematical statistics, in the Australian National University, Canberra—The Secretary, The Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Canberra, August 31).

LECTURER or ASSISTANT LECTURER IN PHYSIOLOGY in the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 10).

ASSISTANT LECTURER AND DEMONSTRATOR IN PHYSICS, and an ASSISTANT LECTURER AND DEMONSTRATOR IN PHYSIOLOGY—The Secretary, Queen Elizabeth College, Campden Hill Road, London, W.8.

ENGINEERS AND PHYSICISTS (Senior Scientific Officer and Scientific Officer grades (Ref. A.246/52A), and Experimental Officer and Assistant Experimental Officer grades (Ref. A.247/52A)), in the Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth and Weymouth areas and Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting appropriate Ref No.

LECTURER (with honours degree, preferably with special qualification in electronics, electron microscopy, photoelasticity or other branch of applied physics) IN PHYSICS—The Secretary, Royal Technical College, Glasgow.

LECTURER (Grade B) IN ELECTRICAL ENGINEERING—The Clerk of the Governing Body, Battersea Polytechnic, London, S.W.11.

ORGANIC CHEMIST (Ph.D.) IN THE CHEMICAL RESEARCH LABORATORY, to work with a team in the steroid field—W. Stansfield, "Lyndhurst", Nether Edge Hospital, Sheffield 11.

PHYSICAL CHEMIST (Ph.D.)—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

SCIENTIFIC OFFICER, male (B.Sc. with first- or second-class honours, or equivalent qualifications, with chemistry as the principal subject) in the Mineral Resources Division of the Colonial Geological Surveys, London, S.W.7, to undertake chemical analysis of rocks and minerals for scientific and industrial purposes, and in particular laboratory investigation of clays, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F318/53A.

REPORTS and other PUBLICATIONS

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Fulmer Research Institute. Special Report No. 1: Radiation Suppressing Coatings for Metals at Elevated Temperatures. By Dr. A. H. Sully, E. A. Brandes and R. B. Waterhouse. Pp. 24+4 plates. (Stoke Poges: Fulmer Research Institute, 1953.) 15*s.* net. [125

Department of Scientific and Industrial Research. Report of the Water Pollution Research Board, with the Report of the Director of Water Pollution Research, for the Year 1952. Pp. iv+64+4 plates. (London: H.M. Stationery Office, 1953.) 2*s.* 6*d.* net. [125

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Mountains and Slieve Gullion. By E. M. Patterson. Pp. 171–188. 2s. 6d. Vol. 55, Section B, No. 9: The Seed Mucilage of *Ascophyllum nodosum*, Part 1. By Thomas Dillon, Kaare Kristensen and Colm O hEochdha. Pp. 189–194. 1s. Vol. 55, Section B, No. 10: Movements of Salmon around Ireland, 2, From Baginbun, County Wexford (1949–1951). By F. A. Gibson. Pp. 195–208. 2s. 6d. Vol. 55, Section B, No. 11: Movements of Salmon around Ireland, 3, from Carnlough, County Antrim (1950 and 1951). By Arthur E. J. Went. Pp. 209–224. 2s. 6d. Vol. 55, Section B, No. 12: Further Identifications of Macroscopic Plant Fossils from Irish Quaternary Deposits, especially from a Late-Glacial Deposit at Mapastown, Co. Lough. (Studies in Irish Quaternary Deposits, No. 8.) By G. F. Mitchell. Pp. 225–282+2 plates. 8s. Vol. 55, Section B, No. 13: The Petrography of the Old Red Sandstone Rocks of the North of Ireland. By Harold E. Wilson. Pp. 283–320+1 plate. 4s. 6d. Vol. 55, Section B, No. 14: Floridean Starch. By Proinsias O'Colla. Pp. 321–330. 1s. (Dublin: Hodges, Figgis and Co., Ltd., 1953.) [185

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